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OF THE
96th ANNUAL CONFERENCE

**AMERICAN RAILWAY
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ASSOCIATION**



1991

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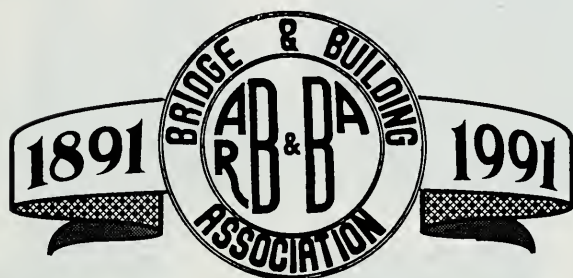
Ninety-Sixth Annual Conference

OF THE

American Railway

Bridge & Building

Association



Held at the

ADAM'S MARK HOTEL

St. Louis, Missouri

September 23-25, 1991

Our heartfelt thanks

to

Walter C. Sturm

Chairman, Centennial Committee



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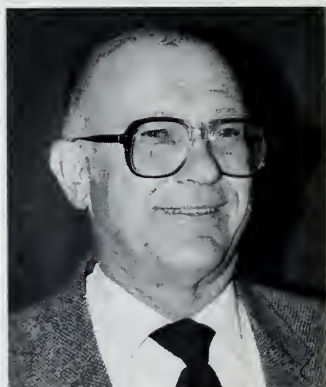


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PROCEEDINGS

Monday, September 23, 1991

Opening Joint Session



President Horney: As president of the American Railway Bridge and Building Association and on behalf of Jerry Cossel, president of the Roadmasters and Maintenance of Way Association of America, I declare the 96th annual conference of the American Railway Bridge and Building Association and the 103rd annual conference of the Roadmasters and Maintenance of Way Association of America to be open and in joint session.

I hope everyone has an enjoyable stay in St. Louis. This is the Bridge and Building Association's 100th anniversary and we have set up a display room around the corner that you are all invited to view sometime during the next couple of days.

It is proper that we pause to ask for divine guidance and inspiration prior to commencing this conference. I would like to call upon Don Sorgenfrei, one of the directors of the B&B Association to give the invocation.

Mr. Sorgenfrei: Shall we stand and pray. Heavenly Father, we thank you for bringing us safely together for this special conference. We thank you for giving us these associations as a means to learn and share experiences with one another. We especially thank you for guiding and protecting the Bridge and Building Association over the past 100 years and ask for your continual blessings on both organizations. We

ask that you be with the speakers, give them a special measure of strength and confidence in their presentations. Grant us success in our endeavors and may we return safely home. In Jesus' name we pray. Amen.

President Horney: Thank you, Don. At this time I would like to introduce the officers and directors of the American Railway Bridge and Building Association who are seated at the head table. As I introduce each person I ask that he stand and remain standing until all have been introduced. I also ask that you hold your applause until all have been introduced. Beginning on my left, senior vice president, Mark Walbrun, project manager, Amtrak, Chicago, Illinois; junior vice president, Paul Saletnik, engineer of buildings, Chicago and North Western Transportation Company, Chicago, Illinois; immediate past president, Byron Burns, structure engineer, Atchison, Topeka and Santa Fe Railway, Topeka, Kansas; treasurer, Jim Williams, supervisor B&B (retired), Elgin, Joliet and Eastern Railway, Newaygo, Michigan. Directors, Don Sorgenfrei, associate, Modjeski and Masters, New Orleans, Louisiana; Bob Carter, general B&B supervisor, Burlington Northern Railroad, Springfield, Missouri; Tom Dunn, bridge engineer, Chicago and North Western Transportation Company, Chicago, Illinois; Michael Bradley, project

engineer, Conrail, Columbus, Ohio; Doug DeBerg, assistant manager-rail, Atchison, Topeka and Santa Fe Railway, Topeka, Kansas; Joe Lileikis, manager bridge construction, Union Pacific Railroad, Salt Lake City, Utah; Don McCammon, manager B&B, Burlington Northern Railroad, Englewood, Colorado; John Creighton, B&B master, Canadian Pacific Rail, Toronto, Ontario, Canada; Johnny Bradley, assistant division engineer-bridges, Norfolk Southern, Knoxville, Tennessee. You may now applaud. (Applause)

I'll now turn the rostrum over to Jerry Cossel, president of the Roadmasters and Maintenance of Way Association.

President Cossel: Thank you, John. The update on conference registration is 110 B&B, 173 Roadmasters, 202 Associates, 15 guests and 114 ladies, for a total of 614.

I would now like to introduce the officers and directors of the Roadmasters and Maintenance of Way Association of America. As I introduce each one, I ask that they stand and remain standing until all have been introduced. Please hold your applause until the introductions are completed.

Beginning on my left, first vice president, Steve Hill, assistant division manager-engineering, Soo Line, Wood Dale, Illinois; second vice president, Ken Welch, chief engineer-planning and equipment, Union Pacific Railroad, Omaha, Nebraska; immediate past president, Keith Pottorff, recently retired director of maintenance systems for the Atchison, Topeka and Santa Fe Railway, Albuquerque, New Mexico; treasurer, Gene Schubel, division engineer, Burlington Northern Railroad, Springfield, Missouri. Directors, Keith Nordlund, project manager, Canadian National Railway, Toronto, Ontario, Canada; Alan Butler, systems engineer public improvements, Conrail, Philadelphia, Pennsylvania; Carl Edwards, assistant division engineer, CSX Transportation, Nashville, Tennessee; Johnny Johnson, manager maintenance of way training, Atchison, Topeka and Santa Fe Railway, Albuquerque, New Mexico; Kendall Koff, project engineer, Southern Pacific Transportation Company, Springfield, Illinois; Pete Murgas, engineer procedures and administration, Norfolk Southern Corporation, Atlanta, Georgia; Herb Clark, director maintenance planning, Chicago and North Western Transportation Company, Chicago, Illinois; James Young, assistant general manager-maintenance

of way and engineering, Southern Pacific Transportation Company, San Francisco, California; Ron Poulsen, director maintenance of way equipment and shops, Union Pacific Railroad, Omaha, Nebraska; Wayne Russell, general director roadway maintenance and planning, Atchison, Topeka and Santa Fe Railway, Albuquerque, New Mexico; Ray Brosseau, assistant supervisor maintenance of way, Canadian Pacific Rail, Toronto, Ontario, Canada; David Smoot, executive vice president, Indiana Hi-Rail, Connersville, Indiana. You may now applaud. (Applause)

At this time I would like to introduce Ernest Rewucki, president of AREA and chief engineer of Canadian Pacific Rail.

Greetings from AREA

Mr. Rewucki: Thank you very much, Mr. President. I am very pleased to have been asked to participate in this morning's joint session. On behalf of the entire membership of the American Railway Engineering Association I would like to extend greetings and good wishes to the members of the American Railway Bridge and Building Association and the Roadmasters and Maintenance of Way Association of America.

I would especially like to congratulate the American Railway Bridge and Building Association on the 100th anniversary of the founding of this Association right here in this city back in September, 1891. Your contribution to the advancement of knowledge pertaining to the design, construction and maintenance of railway structures has been invaluable to the railway industry and you can be especially proud of your excellent bridge safety record.

Our three railway organizations and REMSA have had an excellent working relationship in meeting the challenges that have faced the railway industry over the last several years. It's not that long ago that the main objective for maintenance of way supervisors and railway equipment manufacturers was to develop new work methods, procedures and equipment to reduce the cost of track and bridge maintenance.

Well, today that's not good enough. If we are to remain competitive we have to improve our transit times, our reliability and our on-time performance. To achieve these two objectives means we not only have to maintain our railways at the least possible cost, we must do so

with minimum disruption to traffic. This, I believe, is the main challenge we, as railroaders and railroad suppliers, will face in the nineties. I am confident, however, that if we work together with the same commitment that we have shown in the past, we can meet this challenge.

In closing I would like to thank the B&B Association and the Roadmasters Association for inviting me to participate in this morning's session and to wish all of you here a very informative and productive conference. Thank you very much. (Applause)

President Horney: Thank you, Mr. Rewucki. I would like now to introduce Mr. Vinnie Terrill, president of the Railway Engineering Maintenance Suppliers Association.

Greetings from REMSA

Mr. Terrill: Thank you, John. Presidents Jerry Cossel and John Horney, distinguished guests, ladies and gentlemen. Year after year this time slot is reserved for some welcoming remarks from the president of REMSA and this year is no different. We at REMSA do not consider this invitation routine and I hope that you are not going to find my address a routine one. As a long-time railroader, since 1947, as a past president of AREA, as a maintenance-of-way supplier and member of the REMSA board since 1985 and as a part-time consultant over the past year, I don't consider anything routine.

I am extremely honored, and REMSA is honored, to be able to address this group on its historic 100th anniversary. I've just come from another speech. I spoke to the wives and guests of the B&B, Roadmasters, AREA and REMSA members earlier, and I told them you only have two days to turn the St. Louis economy around. Get out there and do it! I knew you would all be happy to hear that. (Laughter)

Let me take a few minutes to tell you about the new REMSA. REMSA is expanding its role in the maintenance of way field by forming closer and, in some cases, new relationships with the leading industry agencies, FRA, TRB and the leading associations, AAR Research and Test, AREA, Roadmasters, B&B, Railway Progress Institute, the American Short Line Railroad Association, Regional Railroad Association, and others. We have a new executive director who is well known to all of you, hav-

ing been a leading member of Lou Cerny's staff at AREA. Please take the time to welcome Judi Meyerhoeffer, if you can slow her down, out there in the hallway and welcome her here at the Adam's Mark during this conference. Our office is located just outside the hustle and bustle of Washington, D. C., in Falls Church, Virginia. Stop in and see Judi and her assistant, Helen Pape, at their office at 210 North Little Falls Street, or call her at 703-241-8514.

The 250 REMSA member companies have some 20,000 employees from which to draw experience and expertise to help solve industry problems. It is REMSA's intention to support and enhance the railroad industry and to better represent our own membership in a stronger and closer alliance with these agencies and associations. When a problem arises we want to work with the industry to help find a solution. The AAR R&T group, with the support of its member railroads, continues to study both the maintenance and mechanical side of the 125 ton impact to track, freight car and lading. We have been promised a larger part in this picture of our industry's future and we welcome the opportunity to work with the railroads and RPI on their FAST Advisory Committee.

REMSA wants to be included in any studies involving proposed new or changes to the track safety standards. We are looking now for an opportunity to work with AAR's engineering division, the AREA, and FRA as they continue to fine tune the safety standards to what they should be, reliability standards. This is a total industry with a common foe. Let's work together as we must do now to freeze forever the truck lengths and weights. This battle is not over and even though it appears that we have the upper hand, the truckers have the strength through their strong highway supplier and owner associations, their deep pockets, and from sheer numbers to sustain a long and costly battle.

I think we have to look over what minor differences that we may have to the bigger picture, to the railroad industry which includes transit, commuter rail, high-speed passenger, freight, including heavy haul, short line and regional, and the manufacturers and suppliers of materials and equipment, and the contractors who perform some parts of this work, to form a bond that will make our industry prevail. To prevail as a primary mode of transportation for

passengers and freight in North America. Before this can happen we must support anything within the industry that builds on the psychology and the practice of a safe, sound and reliable railroad industry. If we can't bring the railroads to the people, let's bring the people to the railroads.

I think transit growth is great. The five-year highway plan will certainly help continue growth and promote the psychology of rail, help solve pollution problems, save lives and decrease tensions on our highways.

I think commuter rail is great for those same reasons and it's high time we have a high-speed steel wheel on steel rail passenger service in this country.

REMSA supports these railroad additions and extensions. They mean jobs for our diminished work force, our diminished work force on the railroad also, and contractors and they give companies like those that make up REMSA a chance to put together some R&D money with which will help benefit the whole industry.

Those of you who have read George Way's interview in one of our leading industry magazines last month, a REMSA member company I might add, got an excellent summary of what is going on in our industry research. One-tenth of one percent of railroad revenues is put into research. They also got an economic lesson in short term deferral savings which creates long term maintenance problems. As Mr. Way said, "R&D is going on at the AAR but with a smaller budget." He praised REMSA companies for their R&D input but warned that, overall, R&D is decreasing.

This brings me to another side of my favorite subject. R&D is not being decreased in the European or Japanese rail communities, where much of it is being supplied by the governments of those countries. That means when our government comes up with \$750 million in the highway bill for maglev, we'll be looking to the R&D made by Germany and Japan in their, as yet unproven, test ways. That's not right.

What are the positive signs of togetherness in the North American railroad industry? Industry togetherness on the LCV issue; the five year highway bill; transit and commuter rail successes; the makings of what could be the first high-speed steel wheel on steel rail service in North America in the Texas triangle; the solid fact that Amtrak pays more of its operating costs

from revenues than any other world rail passenger system; the 125 ton car studies going on before the fact, instead of after, that has happened with the 100 ton in the sixties; smaller togetherness studies in bio-mechanics, concrete tie rail seat abrasions, rail buckle, and so forth. Where do we need to put our abilities and our strengths? In togetherness (I'm afraid to use the word "union" here), the right way to help defeat California's attempt to gain a waiver for them to preempt the non-road engine and vehicle standards which Congress mandated EPA to do by 1995, is to not allow California to set the nation's air quality and exhaust emission standards for non-road engines. It does not serve Congress' purpose, nor does it bode well for our engine manufacturers or our railroad users. We must act with written comments to EPA by October 21, 1991, to help stop this bad move.

With regard to industry education, REMSA has a \$10,000 scholarship program and others have scholarship plans. Why not a master plan to help educate tomorrow's maintenance-of-way leaders, a common set of specifications, such as California developed for their rail passenger cars and locomotives before they sent a referendum to state voters to tax themselves to build more mass transportation systems? That worked. They did it all and the voters voted to tax themselves to support it. Why can't we apply this system to our freight railroads? To start out with common specs for our maintenance equipment relative to purchasing practices, emissions, noise control, safety equipment, clearances, operating practice, speed, labeling. There is always a need for competition and we can't, nor do we want to, specify competition. But let's start out with the same ground rules and lay out the same base paths before letting REMSA competitors come to bat.

What does quality assurance mean? Let's be sure that the railroads' engineering and purchasing departments are talking the same language and that the line supervisors with whom REMSA members communicate and work have the same interpretation of quality. How better to do that than to sit down together and talk it out. Let REMSA work with you. We promise this will not dampen our enthusiasm to compete for your business and you may even end with more business for which we can compete.

REMSA isn't all serious. We still have a few

fun things to share, like the coffee bar Monday through Wednesday from 7:00 to 8:30 a.m. in the Rose Garden and the Tuesday night reception, which is complimentary for all registered railroaders and their spouses or guests. You'll find the ticket table outside this room where you can pick up your tickets. Don't forget to look at the huge directory board which lists all the REMSA suites. Why not visit them all and say hello to our REMSA company members and your fellow rail industry friends. I'm really proud of our REMSA officers and directors. They have given me their complete support in carrying on our past president's mandate to bring REMSA out of the closet into the heat of the railway industry's kitchen. Give us the chance to show you that we can take the heat if we know that we can share in the rewards that a healthy industry will bring.

We wish you a most successful conference in your 100th anniversary year. Presidents Horney and Cossel, thank you for the time. (Applause).

President Horney: Thank you very much, Vinnie. We have had an outstanding relationship with the Associations and REMSA over the years and I'm sure that in the future we will continue to do so.

At this time I am happy to introduce Mr. Stan McLaughlin, vice president of engineering for the Union Pacific Railroad in Omaha. Stan

has direct responsibility for the design, construction, and maintenance of track, bridges, signals, and other fixed facilities on Union Pacific's 22,000 mile system.

Stan obtained a Bachelor of Science degree in civil engineering from the University of Nebraska and a Masters of Science degree in management from the Massachusetts Institute of Technology as an Alfred P. Sloan Fellow in 1983. He began his career with the Union Pacific as a staff engineer in 1971 and has held various positions in engineering since then. In August, 1985, he was appointed chief engineer of the Union Pacific and assistant vice president engineering in January, 1986, over the combined engineering departments of the Union Pacific and Missouri Pacific railroads. Stan is a member of AREA and served as its president in 1988-1989. He is also a member of the AAR Engineering Division General Committee, the American Railway Bridge and Building Association and the Roadmasters and Maintenance of Way Association of America. He is a chapter honor member of the University of Nebraska chapter of the national civil engineering honor society, Chi Epsilon, and is a registered professional engineer in the states of Nebraska, Kansas, Colorado and Wyoming. Ladies and gentlemen, please join me in welcoming Stan McLaughlin

KEYNOTE ADDRESS

Stanley J. McLaughlin

Vice President-Engineering
Union Pacific Railroad Company



Stanley J. McLaughlin

Thank you, John. Good morning.

Presidents Horney and Cossel, officers of B&B and Roadmasters Associations, ladies and gentlemen. It is indeed a privilege to be selected to give one of the keynote addresses at this year's joint technical conference of the American Railway Bridge and Building Association and of the Roadmasters and Maintenance of Way Association of America, particularly in light of the fact that 1991 marks the 100th anniversary of the founding of the American Railway Bridge and Building Association in this very city. I especially wish to thank B&B President John Horney and the B&B Association Board of Directors for according me this honor. I'm sure we are all looking forward to the variety of interesting topics that will be covered in the next two and one-half days. I especially will be interested in hearing Conrail's senior vice president of corporate systems David LeVan's keynote address tomorrow morning.

I suspect Mr. LeVan will provide you with an excellent overview on the state of the industry. Since he is much more capable of doing this than I am, I plan to restrict my comments this morning to issues that have a more immediate and direct impact on us in the engineering and maintenance-of-way community. In other words, this glorified gandy is going to talk about things that are near and dear to the heart of roadmaster John Doe and B&B supervisor Joe Smith. Specifically, I plan to address the four most significant issues, as I see it, that we engineering and maintenance-of-way managers face in the years to come.

First and foremost is the need to continue to make significant year over year improvement in employee safety. We, at Union Pacific Railroad, have reduced our maintenance-of-way and signal FRA reportable injuries per 200,000 manhours more than 50 percent in the last five years. I believe most other railroads in the United States could make similar claims. Be that as it may, we still have a long way to go. I don't think we can be satisfied until we, as an industry, have eliminated all fatalities and serious injuries and have reduced our reportables to a miniscule number comparable to DuPont and other industry leaders in their respective fields. Improved employee safety is critical for a number of reasons, the most important of which is the pain and suffering injuries cause employees and their families. Above and beyond this, however, a safe work place reaps many side benefits. Without question, employees' morale is at its highest when we provide our employees a safe working environment and when they know that we are genuinely interested in their safety. Our experience at Union Pacific shows that our safety operations also exhibit the highest levels of productivity and do the best quality work. I think we all learned a long time ago that taking shortcuts on safety in the name of increased productivity, in fact, decreases productivity. In other words, the lost time we realize when an employee is injured far exceeds the little bit of extra time it would take to plan and do the job safely the first time around. The

same argument holds true in terms of the quality of the work our employees do. Taking shortcuts on safety in the name of productivity invariably yields inferior quality work which ultimately costs us in the long run. Thus, the final benefit of a safe work environment is purely financial. It doesn't take a genius to figure out that employee injuries cost us a lot of money. This is money needlessly spent that could be utilized to maintain bridges and track and provide the associated employment opportunities for our maintenance-of-way people.

So how do we continue the trend of improvement in employee safety? First, we must continue to improve work procedures and strive to achieve a risk-free work environment. Certainly much has been done in the industry during the last two decades I have worked for the railroad in the way of mechanizing high risk labor intensive operations. However, we are still experiencing far too many injuries that relate directly to prolonged physical activity or one-time over-exertion that could be eliminated. Almost every railroad has made significant progress towards providing equipment with booms to eliminate heavy lifting, but there is still a lot of room for improvement in this area. Certainly I think we all agree that the opportunities for continued mechanization of labor intensive tasks to reduce the potential of personal injuries is a fertile field. Our first-line supervisors can and should be the key to these mechanization opportunities as they are the people that do the work on a daily basis. In this regard, additional training and education will be required. We need to ensure our field managers have the proper safety training to enable them to focus on what it takes to do the job safely.

This leads me to the second and most important of potential improvement opportunities involving employee safety. That is, the need for all of us in the management ranks to become completely devoted to the safety process. Safety is not something that can be handled in a 15 minute meeting on Monday mornings. Safety is a 24 hours a day, seven days a week, 52 weeks a year state of mind that must be shared by every single employee in the organization before we can be completely successful in this area. Our union employees will not take this effort seriously until such time as they are convinced that their managers are completely and

wholeheartedly committed to providing a work environment free from the possibility of accident and injury. One way to help achieve this end is to involve all our employees from the outset. This requires improved communication and leadership skills on the part of all of our non-agreement supervisors. Our best managers at Union Pacific in terms of safety, quality, productivity or any other measure are those that listen to and involve employees in every aspect of their work. They simply take the time to tell all their employees not only what they are expected to do, but why they are doing it, and then solicit their ideas on how the job can best be done. An employee who feels his or her opinion and ideas are valuable is an employee that is much more likely to be dedicated to the safe and efficient completion of the task. I know of no magic formula to convert managers or employees to this process other than hard work and devotion over time. One thing I do know though, is this change will not come about unless we, the managers of the railroad, take the first step and demonstrate 100 percent devotion to the safety process.

The railroad industry has an ominous history in regard to safety that we must overcome, but we can and must succeed. I am going to provide you with some mind-boggling statistics relative to my own railroad that you may find hard to believe; particularly in light of the fact that there are few, if any, in this crowd who have worked in this industry for over 40 years. Combined, since World War II, the Union Pacific, Missouri Pacific, Western Pacific, and the Katy, for all crafts, averaged the following number of on-duty employee fatalities per year in each of the following decades:

1940s.....	43	1970s.....	16
1950s.....	20	1980s.....	8
1960s.....	14	1990s (to date).....	3

If you are a statistician, you can point to a 93 percent reduction in fatalities in the past five decades, and certainly our improvement has been good. However, if you are a family member of one of the employees whose life was prematurely ended in the 1990s due to some unfortunate on-duty accident, I doubt that this improvement has much meaning. I'm sure you all get my point; that is, we will not be completely successful until all fatalities and

disabling injuries have been eliminated.

Finally on the topic of safety, there is one more carrot at the end of the stick to entice us to continue to improve in this area. That is, if we don't do it aggressively and willingly for all the proper reasons I have already stated we will be forced in this direction by additional federal and state regulations. These can be politically motivated, particularly onerous, and may not even directly relate to improved safety if not properly thought through. For example, the proposed FRA fall protection standards are, for the most part, good, sound regulations that will enhance safety for our maintenance-of-way employees. Many of the elements of the proposed regulation have already been adopted by the railroads. However, the proposed standards have a few ridiculous elements that will drive up costs without providing any additional benefit in the way of employee safety. For example, the requirement to use fall protection for employees working as low as six feet above the ground. Almost everyone realizes that there is no common sense basis for this minimal height requirement since an employee who falls off a bridge six feet high would actually hit the ground before a lanyard or net would even take effect. Hopefully, common sense will prevail and a height somewhere between two and three times the present proposed minimum will be established that is related to a real, and not perceived, increase in injury risk. The bottom line is if we do our jobs right the first time, we won't have to argue about regulations such as this at a later date and there will not be any safety statistics to support the need for such regulations.

One additional point in terms of safety. We must not overlook the safety consequences of the work we do in maintenance-of-way on other employees in other crafts and on the general public. We must continue to improve the quality of our track and bridges in order to reduce the possibility of derailments and associated injuries to others outside the maintenance-of-way areas. I don't need to tell you how much grief one catastrophic roadway-caused derailment can cause us and the industry in general.

This leads me to the second issue that I would like to talk about; that is the need to continue to improve the efficiency of our operations and the quality of our track and structures.

Deregulation has shoved us into an entirely new ball game. Hopefully none of us are so naive as to think that we will ever return to the days of fat maintenance budgets and high levels of employment. The facts are, we are in a very competitive industry and costs will continue to be an increasingly important factor. Therefore, we need to continue to find ways to improve productivity and efficiency while at the same time enhancing the quality of our fixed plant. The key to this problem is evaluating the life cycle costs of our equipment and materials. For example, it certainly costs more to build a steel or concrete ballast deck bridge up front than to replace an open deck timber pile trestle in kind, but the increased life of the structure and the reduced ongoing maintenance costs may well be worth it; particularly in heavy tonnage main lines. Similarly, installation of wider decks and footwalks and handrails on new or replacement structures may be very cost effective in the long run where balanced against improved safety and the additional costs of providing fall protection for people working on top of the structure if these enhancements are not provided.

Another example of improved technology is the use of concrete ties and fixed fasteners. Even though the upfront cost of installing concrete ties may be considerably higher than the use of timber, the long range benefits must be evaluated in each and every case. Please do not misunderstand what I'm trying to say. I'm not advocating that we discontinue building timber structures or utilizing timber ties. In many, and probably the majority of the cases, timber is still the best cost alternative not only in terms of up-front costs but in terms of life cycle costs. What I am suggesting is that we need to look at each and every application and make an economic judgment based on life cycle costs as to which is the best material to use.

For example, we at Union Pacific are now installing concrete ties out-of-face in some of our heavy tonnage, heavy grade, heavy curvature territories where we experience very short timber tie life and where we have extremely high ongoing maintenance costs due to differential plate cutting and gauge widening in wood tie track. Our analysis tells us that we are better off putting concrete ties out-of-face in these territories rather than experience the continuing ongoing high maintenance costs. However, for the vast majority of our railroad and

operations our best economic judgments tell us that continuing our traditional program replacements of timber ties utilizing cut spikes is the way to go. Our five-year plan includes an average of approximately 1,750,000 ties per year of which only approximately 150,000 will be concrete. Again, each railroad will have to make their own economic judgments for their own particular circumstances.

The Burlington Northern uses a smaller and less expensive concrete tie than we do; consequently, they can justify a larger portion of their annual tie program for concrete ties. Based on how and where they are using their ties, I'm sure they feel that they are making the right life cycle cost decision; just like we feel we are making the right decision for our applications at Union Pacific. The point is that continual quality improvements in our fixed plant in the face of declining budgets is a must. It is imperative that we positively focus our efforts on how we can do more for less in the future, rather than cry about how nice things were in the good old days when many of us had fat budgets and virtually unlimited resources to maintain the railroad. The only thing constant since deregulation, and in the years to come, is change and the only way we in maintenance-of-way will survive is to lead, or at least keep pace with, this change.

The third issue that I want to address and one that is most troubling to us railroad maintenance-of-way people is the growth of heavy axle loads. Like most of you, I'm troubled by the trend towards increased axle loads and have not been a proponent of raising our axle loads above the typical 263,000 pound gross weight 33-ton axle limitation common in the industry the last quarter of the century. I guess it would be nice to stick our head in the sand and say that we as a railroad industry plan to stay with this limitation. We could probably do this if our competition was restricted to other railroads. The fact is, it isn't. Our biggest competitor is trucks and other modes of transportation that have a much lower cost structure than we do as a railroad industry. Consequently, for us to be competitive it certainly appears that increased axle loadings are the wave of the future. Efficiently moving more tons over our existing fixed plant is the only way we can effectively compete. Additionally, the heavy axle load tests at the FAST Track at Pueblo as well as tests on

a number of railroads seem to indicate that the exponential increase in fixed plant maintenance costs attributable to heavier axle loads will be more than offset by cost reductions in the mechanical and transportation areas per equivalent gross ton miles. Some railroads have already made the decision to go to 112-ton, 286,000 pound gross weight cars with 36-ton axle loads and I think it's only a question of time until 125-ton, 315,000 pound gross weight cars with 39-ton axle loads will be the rule rather than the exception. Needless to say, this will force us to continue to improve the strength and quality of our bridges and track structures to withstand these heavier loadings. Consequently, our challenge is to design and construct bridges and other structures that will withstand 315,000 pound, or possibly even higher, loads while minimizing ongoing maintenance costs. Similarly, we need to continue to improve the quality of our rail, track, and roadbed and our maintenance practices in order to minimize track maintenance costs in light of the increasing axle loads. As I see it we have two choices in regard to heavy axle loads: (A) We can be dragged kicking and screaming down this road and be behind the eight ball when the decision to adopt heavy axle loads is ultimately made, or (B) we can lead the charge by building a fixed plant that can handle these heavy loads and by providing management with reliable information on our incremental cost increases to handle this business. The position I have taken with our management at Union Pacific relative to heavy axle loads is very simple: Yes, we can safely handle heavy axle loads on our railroad; but I think it would also be nice if we make a profit in doing so!

The fourth and final issue that I wish to touch on is the subject of labor/management relations, particularly in light of the recent PEB rulings. I see that Tom Watts, Union Pacific's vice president of labor relations, and Mac Fleming, president of the Brotherhood of Maintenance of Way Employees, are on the docket at 10:45 this morning to discuss this subject. I'm sure that this will be an interesting and enlightening presentation that will provide much more insight into this topic than I will be able to bring to the table. However, I would be remiss if I did not at least share some of my views on this important topic. The most important point that I wish to make is that the

President's Emergency Board is behind us and there is no point in wasting time evaluating who were the winners and losers as a result of the PEB. The main thing that we need to do now is take what the PEB has provided us and sit down with the general chairmen and formulate agreements and working relationships in the spirit of the PEB that create a win-win situation for everyone to the extent that this is possible. As I said when I discussed safety, employee morale is a key issue. The railroads have the opportunity to take the PEB guidelines and formulate new work rules that can enhance our productivity. I think the important point is how we utilize the benefits afforded by the PEB. For example, the PEB granted the railroads the right to expand our use of system and regional gangs. Now it is up to us to show the unions that we intend to utilize this freedom in a thoughtful and conscientious manner. The PEB system gang guidelines are structured such that system and regional gangs can be a positive experience for the majority of our employees. If we sit down with the general chairmen up front and show them how we plan to utilize our system gangs and how our plans yield more stable work opportunities for their employees and if we provide sufficient up-front information to our employees, I believe we can end up with a better working environment than we have now. I'm a firm believer in the old saying that what goes around comes around and if we abuse any of the gains that have been made under the PEB guidelines they will come back to haunt us when the present contract expires in 1995. I think you catch my drift. Certainly there are some important features in the PEB in terms of system gangs, seniority districts, and work flexibility that can improve our productivity and efficiency in the years to come. The challenge is how we implement these changes without antagonizing an already suspicious work

force. We must be able to prove to our employees that we are not a bunch of ogres out to make life miserable for them at every turn. I think I can best illustrate this by way of an example. The unions are afraid that we are going to establish system gangs that will require employees to work in the Pacific Northwest one day and in the Gulf Coast the next. This problem is easily remedied. All we have to do is provide informational schedules, albeit subject to periodic updates, that tell the employees up front where each gang will be working that year. Then the employees will have the opportunity to bid the gang or gangs that best fit their personal situations, a simple concept, but an important feature as far as the employees are concerned. Communications with the employees and their union representatives and a common sense approach to the applications of the PEB rules can and will make a big difference. I am confident that we will respond to this challenge and restore the confidence of our employees in our ability to effectively and efficiently manage our most valuable resource — our engineering and maintenance-of-way employees.

With that, I conclude my remarks. Once again I would like to thank the B&B and Roadmasters associations for inviting me to speak to you today. I appreciate your attention and I would be happy to answer any questions in the time we have remaining. Thank you. (Applause)

President Horney: Thank you very much, Stan. At this time I would like to introduce one of our past presidents Wally Sturm, of the Elgin, Joliet and Eastern Railway, Joliet, Illinois. Wally is chairman of the B&B Association's centennial committee and has worked very hard this year to put some of our festivities together.

B&B CENTENNIAL COMMEMORATION

Walter C. Sturm

Project Manager

Elgin, Joliet and Eastern Railway Company

Thank you, John. Ladies and gentlemen, members and guests of the Association, welcome to the Centennial Conference of the American Railway Bridge and Building Association. One hundred years ago the men who founded the Association began to gather here in St. Louis to establish an association comprised of those who constructed and maintained the bridges and buildings of America's railroads. At that initial meeting they decided to hold annual meetings for the dissemination of ideas through the reports of committees on selected subjects and papers of mutual interest to the

members and the interest of railroads in general. The succession of officers, directors and members of the Association have diligently carried out this original premise for 100 years.

The Association is presenting a display of artifacts from the first 100 years of the Association together with a video presentation of the history of the Association. Please stop by during the conference and view the exhibit.

At this time I would like to include the following letter into the official Proceedings of the conference:

THE WHITE HOUSE

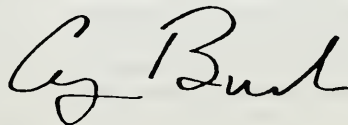
WASHINGTON

June 12, 1991

I am pleased to send greetings to all those who are gathered in celebration of the 100th anniversary of the American Railway Bridge and Building Association. Congratulations on this milestone.

During the past century, your members have played an integral role in the development of railways as a means of commerce and travel. On behalf of all Americans, I thank you especially for your work here in the United States. As our Nation's economy has grown, so has the need for dependable rail service that can accommodate heavier, faster trains and more sophisticated equipment. You have helped to meet that need through the application of your knowledge, creativity, and technical skill. Indeed, through the design and building of stronger, more durable bridges, tracks, tunnels, and other facilities, you have helped to ensure that railways remain a viable method of surface transportation.

Barbara joins me in sending best wishes for every future success.



Mr. Sturm: Our first special feature on the program will be a review of bridge and building construction over the last 100 years. For the past 16 years, William Worthington has specialized in the history of mechanical and civil engineering at the National Museum of American History. He is the author of a number of articles on the history of technology. Mr. Worthington.

Mr. Worthington: Thank you, Mr. Sturm. By way of introduction let me say that I have been asked to present a paper which reviews the history of railroad bridges and buildings, illustrated with photographs and prints from the engineering archives of the Smithsonian Institution. As our collections contain literally thousands of photographs and prints which

document this history it was a daunting task and one in which I had to be selective rather than focus solely on the last 100 years occurrences that are likely to be familiar to most of us. I have chosen to discuss a more distant past and conclude with a look at the future. I am sure you will excuse me if your favorite structures do not appear or if there seems to be an eastern bias in these illustrations. The latter is readily explained. Simply put, because of our location so far much of our collections have come from eastern sources. The images you will see are not, by today's standards, always the best quality. They are, however, no less important. For in some instances, they are the sole record of significant events and people.

HISTORICAL SURVEY OF AMERICAN RAILROAD BRIDGES AND BUILDINGS

William Worthington

**Division of Engineering and Industry
Smithsonian Institution**

To many of us, history is nothing more than a vague sense of past events and un-named people. It is unlikely that we feel any real attachment to either, although we will readily acknowledge that something took place and surely there were people involved. The connection between that world and the one in which we live is not always readily apparent, especially when we have no clear image of the past. There is no question that we like to think we understand the present, but can we really, without considering some of those distant events that helped shape our surroundings?

As a result of a closer inspection of examples of railroad bridges and buildings constructed during the 19th century and early 20th century, we may be better able to understand this evolutionary process. We may also develop an appreciation of the forces that have caused us to discard some ideas and champion others. It was in the course of the sorting-out process that a group of 40 or so bridge superintendents met for the first time in St. Louis in September 1891. These men were described as being "...a body of well-educated and wide-awake practical railroad men, who came together in their

earnest desire to impart information to each other and thereby improve the class of work in their care on railroads."¹ This paper is a look at conditions leading up to and just beyond the founding of what today we know as the American Railway Bridge and Building Association.

As with any new invention, when railroads first appeared there were those individuals totally opposed to the idea. Other more open minded persons approved, but albeit with a cautionary approach. One such viewpoint offered in 1825 suggested that "Nothing can do more harm to the adoption of railroads than the promulgation of such nonsense as that we shall see locomotive engines traveling at a rate of 12, 16, 18, 20 miles an hour."² Had this vision proven true, there is little likelihood that the American Railway Bridge and Building Association would be meeting in St. Louis, and most significantly, there would be precious little railroad history to review.

It was 1831 when Robert Stephenson's steam locomotive, the John Bull, first ran in New Jersey on the Camden and Amboy line. By the mid-1830s when regular rail service was well established, trains were already traveling at 35



The versatility of the wooden trestle made it an extremely attractive form of bridging. It could be erected quickly covering long distances across almost any terrain often using timber felled locally.

miles per hour. Today, we stand over 150 years from these events and the beginning of railroading in America. The John Bull, the world's oldest operational railway locomotive, is now a much venerated museum object located in the National Museum of American History. On display next to it is another national treasure, and for us, one just as important. It is one of the three trusses that made up this nation's first iron railroad bridge. Built in 1845 by Richard Osborne for the Philadelphia and Reading, it saw main line service near Manayunk, Pennsylvania, until 1901. These two artifacts mark our beginning point. They have been accorded special consideration because of their age and pre-eminence and are deemed national treasures. As is usually the case, when any event or object becomes commonplace, those which follow are not necessarily accorded a like veneration. So has it been in the history of railroad structures. Our knowledge of many of the events and people coming after the John Bull and Osborne's bridge is limited to what is apparent to us now only in old photographs, drawings, and written descriptions.

What better way to begin a railroad and

insure its permanence than by building it of stone. The number of existent early 19th century masonry bridges is strong affirmation that this policy was correct. But despite the strength and durability it provided, it was apparent from early on that for economic reasons stone was not the ideal building material. Stone work progressed slowly and expensively, and as rail lines moved further from suitable local sources of the raw material, prohibitive transportation costs further discouraged its continued use. As an alternative, there was wood.

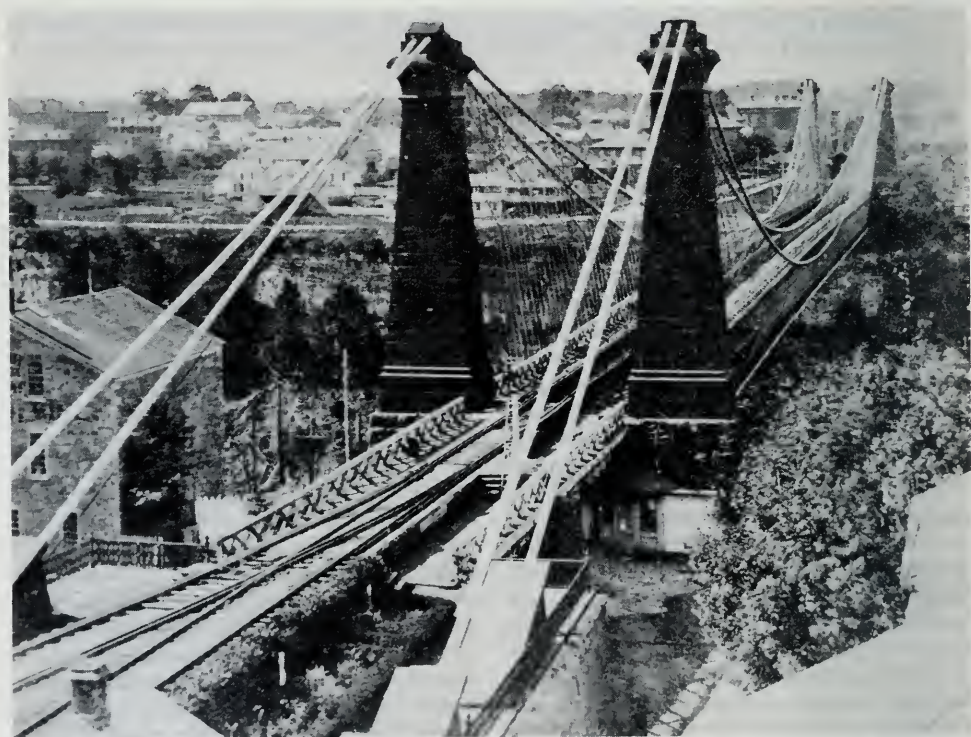
America in the early 19th century could easily be characterized as a wooden nation. It is said that, as it spread across the continent, civilization literally hewed its way through barricades of timber.³ This superabundant and pervasive supply of building material was utilized in every conceivable way—there were towns built completely of wood, with wooden sidewalks, buildings, roadways, and piers. Waterwheels, windmills, ships, boats, wagons, canals, furniture, and housewares all were made of wood. Nearly anything that could be made by man could be fashioned from wood—at one time even our clocks had wooden gears, and

there is the story of the individual known as the Mohawk Dutchman who traveled about the New York countryside dressed in suit of wooden clothes. It is no wonder then that those who built railroads also took advantage of this readily available, plentiful, and cheap building material.

The adaptability of this universal building material promoted the development of railroad bridges to such an extent that Americans soon took a leadership role in bridge truss design.⁴ The goal of patenting a new and better design for wooden truss bridges became one of the leading get-rich-quick dreams in this country. Between 1797 and 1860 the United States Patent Office issued at least 51 patents for wooden bridges. As can be imagined, some amounted to nothing more than schemes on paper, others proved to be well-reasoned applications or at least good approximations of mechanical principles. Although some used iron fittings and fastenings, others reflected

such a single mindedness as to be joined entirely with wooden pins or trenails (trunnels). Among the better known and more successful designs were those by Theodore Burr, Lt. Col. Stephen Long, Ithiel Town, William Howe, and Thomas Pratt. To be sure, wood did not offer the permanence of stone but, with care, such bridges would serve a reasonable time and what did it matter, when the object was to extend the line as quickly and cheaply as possible, often in advance of actual need. The idea was to build up a future paying traffic.⁵

There is certainly no question that railroads work best when built on a smooth, flat plain. But, as the American terrain is hardly like that, it was necessary to create something that approximated that ideal as closely as possible. Rises could be cut down and low areas could be made level with fill, but in rolling or low country moving the volume of material needed was both a tedious and costly undertaking. The job of leveling depressions might be done far more



Trains of the New York Central and of the Great Western Railroad crossed the Niagara River Gorge on the top deck of the suspension bridge designed by John A. Roebling. Completed in 1855, it was the only suspension bridge to carry railroad traffic in this country.



Cantilever construction, introduced to this country by C. Shaler Smith in the 1860s, made relatively routine work of bridging the broad and deep Pecos River valley. In the 1940s a heavier and stiffer steel cantilever viaduct replaced the one completed in 1892.

reasonably and quickly by bridging with wooden trestles. These continuously supported structures at first might seem to be only an expedient measure, but good trestle work was expected to last from fifteen to twenty years and repairs could be made at relatively small cost. Perhaps the strongest recommendation for using trestles came from their versatility. It was possible to start off across any terrain and construct a reasonable level right-of-way in a relatively short time. In an effort to make the work more lasting, and if conditions permitted, a trestle might later be turned into a permanent embankment by filling it in with earth. More to recommend the filling at later date than during construction was the fact that by transporting the fill material along the completed line, it could often be done at less expense than had it been carried out as part of the primary work. Because of the cost and more importantly as a result of the ongoing demand to extend the rails into new markets, follow-up work was not always carried out.

The Two Medicine Bridge on the Pacific Extension of the St. Paul, Minneapolis and Manitoba Railway is perhaps the ultimate example of the 19th century wooden bridge builder's art. When completed it was some 751 feet long and standing 211 feet high was one of the tallest timber trestles ever assembled. But by the time it was constructed in 1892, it was an anachronism, for railroad bridges, especially of this size, generally were being made of steel. Like most decisions involving railroads, the one made to construct this bridge of wood was influenced by economics. It was far more practical to proceed with the construction and avoid a probable delay in track laying then it would have been to wait for a steel bridge to be designed, fabricated, and shipped.⁶ This choice was made despite the need for more than 750,000 board feet of lumber and the fact that a wooden structure would be under constant threat from decay and fire. The rationale in this case is illustrative of a key element in the 19th century approach to railroad construction. It

was observed as early as 1855 when civil engineer John A. Roebling, an immigrant from Germany, characterized America as "...a country where the engineer's job is to make the most out of the least."⁷ The same idea was echoed some six years later by engineer John B. Jervis when he wrote, "It cannot be denied that in many cases in this country, considerations of expense absolutely control the question, and leave the engineer no choice."⁸

Who were these men who built the railroads? The 19th century was a time when a great many structures were the work of practical engineers—individuals schooled in experience. The title civil engineer was used less frequently than today and when applied, it tended to be more encompassing. It was not until late in the century that those actually schooled in the art of building came to dominate the profession. Until 1840, when 13 graduates of Rensselaer Polytechnic Institute received civil engineering degrees, the only source of domestically trained professional engineers had been the ranks of the U. S. Military Academy at West Point.⁹ Europe, on the other hand, had a tradition of technical schools where prescribed courses of study led to professional engineering degrees. As a result, immigrant engineers tended to be far better trained in the field of civil engineering than native born practitioners. A great number of 19th century American civil engineers were either self-taught or were the product of what has sometimes been referred to as the "New England system". Through this process, which lasted a good part of the century, our engineers like our physicians and lawyers could be trained through an apprenticeship by "reading" with those already skilled in the art. In the words of one "graduate", instruction, if it might be called that, "...consisted chiefly of the student's privilege to ask a question if he chose and get an answer if he could: in addition to which he had the further privilege of learning from the work assigned to him in field or office. Of formal instruction, of recognized or regular supervision, there was none. If the pupil wanted to learn he could, and if he didn't, he need not."¹⁰ Our railroads then were borne of the skills of the individuals learned in one of these diverse methods. From each came good and bad engineers. One of the best and perhaps most successful of the practical engineers was Wendel Bollman (1814-84), for many years

master of road of the Baltimore and Ohio Railroad, where he was in charge of all ways and structures.

Bollman's formal education was gained in the public and private schools of Baltimore but ended at about age 11. He was then briefly apprenticed to apothecaries in Virginia, but due to illness he returned to Baltimore. It was there that when recovered he apprenticed himself to a carpenter. At a time when carpentry work was slack he obtained work with the Baltimore and Ohio Railroad which, so it happened, was preparing to lay its first track. He progressed through various positions and in recognition of his abilities in carpentry, he was promoted to foreman of bridges. Typical of many railroads' rush for expansion, most of the line's early bridges were of wood. It was a given that, in time, they would be replaced with structures of iron. Iron bridges were actually composite constructions and as Richard Osborne had demonstrated in 1845, it was necessary to employ both wrought iron and cast iron. Cast iron, because of its brittleness, was suitable only for compression members while the more fibrous (and expensive) wrought iron was suitable for tension members.¹¹

In about 1850 consummate bridge builder Bollman had devised an intricate truss system of his own, but not of wood. Rather it was of this composite construction with characteristics of both truss and suspension bridges, and bore the sobriquet "suspension-truss". The distinctive Bollman truss would become the design of choice for many of the bridges that the B&O and several of its subsidiary lines used to replace its first generation wooden structures between 1851 and 1870. Perhaps the most daring and by far the largest example of these structures was built at Harpers Ferry, Virginia, in several stages starting in 1851. It was necessary to build the bridge with a "Y" configuration as a branch leading from the Shenandoah Valley joined the main line following the upper Potomac River as both crossed the latter between Maryland and Virginia (now West Virginia). Converted to highway use in later years, the bridge remained standing until it was washed away in the flood of 1936.

Patents and designs for iron truss bridges were nearly as numerous as those for wood. Despite differences in the characteristics of the two materials and the need to account for these

differences, the configuration of several wooden trusses—the Pratt and the Howe in particular—transferred nicely to iron construction. Prior to the 1880s, it was possible for bridge builders to choose between wood and iron construction. Iron, of course, had the advantages of greater strength, but it tended to be more costly than wood. However, in areas where the wood supply was limited and materials had to be hauled in, it often became a question of time versus cost.

Certainly our bridge building history is not without its failures and a survey would not be truthful without at least touching on the subject—some bridges for one reason or another did fall down. What might be typical of the bridge collapse scenario was the collapse of the Bussey Bridge at Roslindale, Massachusetts, which carried the Dedham Branch of the Boston and Providence Railroad across a suburban highway. Not only did the bridge fail but in so doing it took with it, on March 14, 1887, six of the nine cars of a busy commuter train, and 23 lives. This strange, skewed hybrid started life as a pair of wooden trusses encased in fire-preventing tin sheeting—hence its early name—The Tin Bridge. In time one wooden truss was replaced with an iron Pratt truss. This truss later would be moved to the opposite side of the bridge in order to replace the remaining wooden truss and in its place would be erected something approximating an iron Whipple truss.¹²

Despite concerns prompted by the occasional discovery of loose nuts lying under the structure, it remained in use. Its failure, however,

was the direct result of the fracture of two of the hangers that suspended the track structure from the top chord. They proved to be poorly designed and of insufficient strength for the load they were intended to carry. As they had been severely fractured for some considerable period, it was only a matter of time before they failed by complete separation. It was not a case of poor workmanship, for the links were made strictly to specification. Rather, it was, in the words of prominent engineer Theodore Cooper, "...an abortion in design and construction in which no engineer had any part."¹³ The practical engineer responsible for the work was so naive concerning bridge design that he did not realize the essential function of the hanger loops nor that one truss carried a greater part of the load. There is no doubt that it was clearly the fault of the builder, but also of a system that required inspections but did not see that they were carried out, or determine in advance that the company—the Metropolitan Bridge Company—responsible for it existed nowhere but on paper.

Despite this example of a total lack of a scientific approach to bridge construction, a modest amount of testing had been taking place in both design and construction for a number of years. The original Hartford Bridge at Hartford, Vermont, had been destroyed when the Montreal Express left the tracks while crossing and embers from the ensuing burning wreckage ignited the bridge as well. Testing of the replacement bridge is all the more interesting for it occurred in the very same year, 1887, as the Bussey failure. Typical for the time,



Both rail and vehicular traffic cross the Mississippi on the Huey P. Long Bridge. Impressive not only because its total length is some of 22, 975 feet, but its price in 1935 was some \$13 million.

locomotives were used to provide a moving load. In this case, deflection of the deck was measured directly as various combinations of twelve fully provisioned locomotives, with a combined weight of 854 tons, were run across the bridge. In an age that still relied heavily on empiricism there was hardly a better method of testing. Similar results, however, might be computed just as readily in the sterile setting of an office, thanks to Theodore Cooper's work in developing sound ratios of proportion and loading.

Not all bridge-related railroad tragedies were caused by engineering failures or poor workmanship. The illustration of a fully loaded passenger train cascading from the end of the track into a river dramatically demonstrated what might happen to a runaway were it to meet the open draw of a typical swing span. Although car floats and ferries were widely used, movable bridges by the late 19th century had come to be an intricate part of the nation's rail network and such tragedies were not unknown. The Scherzer Rolling Lift Bridge Company of Chicago took great care to point out that this could not happen with their product. As the movable span raised to a vertical position, it became literally a solid wall across the tracks that guaranteed runaways would not end in a watery grave. Upon reflection, however, one might seriously question the preferability of slamming into a wall. Perhaps a more significant feature, one that would recommend this type bridge for the close confines of a city or use across a narrow water way, was the unique characteristics of the deck as it lifted to roll back from what on an ordinary bascule bridge would be the trunion. In so doing it thus created greater horizontal clearance for passing ships.

Perhaps the most unusual railroad bridge of the 19th century, from our perspective as well as its own time, was John A. Roebling's Niagara Suspension Bridge completed in 1855. Today, we would not consider a suspension bridge stiff enough to carry the concentrated load of a railroad locomotive—and it would not be. In fact, Roebling acknowledged that these bridges generally were "...looked upon as loose fabrics swung up in the air as if for the very purpose of swinging."¹⁴ The Niagara Gorge, however, presented two serious physical challenges—a depth of some 250 feet and a width of over 800 feet. With no possibility for false-

work, scaffolding, or other devices to facilitate construction, only the technology of the suspension bridge was adequate to meet the needs of the setting. Fortunately, in this instance the time was right, a suspension bridge could also meet the demands imposed by the still relatively lightweight railroad rolling stock.

Rail traffic made the crossing on the upper deck, while vehicular traffic moved on the lower. Roebling overcame the inherent flexibility of the suspension bridge by giving his example weight, trusses, and stays. Stiffness was obtained principally by joining the upper and lower wooden decks with vertical posts and diagonal rods thus forming deep trusses. Despite his several strategies for limiting movement, which involved stay cables that tied the decks to the gorge walls, and holding rail traffic to five miles per hour, there was nonetheless some flexing of the deck truss.¹⁵ Perhaps it was this that led Mark Twain to remark, "Then you drive over to (the town of) Suspension Bridge and divide your misery between the chances of smashing down 200 feet into the river below, and the chances of having the railway train overhead smashing down onto you. Either possibility is discomfiting taken by itself, but mixed together they amount to positive unhappiness."¹⁶

As events unfolded, the Niagara suspension bridge would be the only such railroad bridge actually constructed in this country. But, even as Roebling worked on that bridge, plans were being laid and work begun on a similar structure over the Kentucky River in Jesamine County, Kentucky, for the Lexington and Danville Railroad. Work had progressed as far as completion of the stone towers when in 1857 financial panic and bankruptcy stopped the project. With the intervention of the Civil War the project was finally canceled altogether. The idea of a railroad suspension bridge, however, did not die with the abandonment of the high bridge project. Over a period of some 25 or 30 years, beginning in the 1870s and lasting until at least 1905, a group of entrepreneurs lobbied for a massive double-deck railroad and highway suspension bridge across the Hudson River at Anthony's Nose near Peekskill, New York. It was intended as a direct route for joining the rich coal regions of Pennsylvania to New England markets. Although extensive plans were drawn up, backers enlisted, and a colorful

promotional lithograph distributed, the days of the railroad suspension bridge were over. Despite claims to the contrary, work was never begun. There were simply better ways to build railroad bridges.

One of the most significant steps taken in bridge construction during the post-Civil War period was the modern application of the ancient method of cantilever construction. Using no temporary support or falsework to support the ongoing construction as in a truss bridge, a cantilever structure literally supported itself as it was being assembled. Bridging deep, broad expanses by this method would become a relatively routine task. The first such bridge, interestingly, was erected at the site of and as a replacement for the Roebling bridge across the Kentucky River. With the old Roebling stone towers in the background, C. Shaler Smith successfully assembled the relatively delicate iron deck truss and two supporting towers of the first modern cantilever. Starting at the ends, the self-supporting structure was pin connected, and only two temporary wooden piers were used to carry out the work. The bridge remained in service only until 1910. In that year, it was reconstructed and a new heavier and larger steel truss and towers were built around it. Finally in 1929, Roebling's stone towers were removed as they stood in the way when the bridge was double tracked.

During the 1870s and 1880s, technological developments in the manufacture of steel led to a viable steel industry in this country. The resulting steady supply of reasonably priced product in a variety of shapes, for the first time permitted not only the construction of an all-steel railroad bridge such as that at Glasgow, Missouri, but in essence it established the pattern for all future bridges. Steel would become the primary material for railroad bridges. But, despite this improvement, corresponding advances in locomotive design and construction that enabled them to haul more tonnage created the need for even stronger bridges. Structures that were otherwise sound, were simply not sturdy enough to carry the increased weight of each piece of new equipment, nor stable enough for safe passage at road speeds. Typical of the rapid increases in the weight of locomotives were those used by the B&O. In 1865, the heaviest engine weighed some 91,000 pounds. Just 25 years later (1890), the extreme had

increased some 46 percent to 133,000 pounds. By 1915, 25 more years, the increase in weight would amount to over 246 percent, or 463,000 pounds.¹⁷

Demands made on bridges by the ever increasing loads of more powerful and heavier engines and cars prompted the replacement of countless bridges some, in fact, several times before the last century was gone. Bridges that limited the speed of passing equipment to 15 miles per hour or less simply had no place in a modern rail system. It is no wonder then, that in 1901, after only 22 years in service, the nation's first all steel bridge at Glasgow, Missouri, had to be replaced by an even heavier steel bridge.

The coming of all-steel construction might be seen as the end of a sorting-out process. Late in the last century in his *History of American Railroad Bridges*, engineer Theodore Cooper observed that "After an experience unequalled for its variety and extent, we are arriving at a very general uniformity in the styles of bridges to be adopted for different spans. Today the use of a peculiar form of truss, member, or detail is due more to the special necessities of the case than to the idiosyncrasies of any particular individuals. While no two bridges are exactly alike, there is a general approximation of certain broad types in styles and details."¹⁸ Economic construction, always a consideration best expressed in uniformity and standardization, played a major role in the process. As a result, there is in 20th century bridge design a sense of sturdy sameness. Smaller bridges are most likely to be assembled of adaptations of Pratt or Warren trusses—trusses devised in the first half of the 19th century. Nonetheless, in the last 100 years there have been large dramatic bridges such as the continuous truss Sciotoville Bridge (completed in 1917) with its two 775 foot spans over the Ohio River. The 720 foot channel span of the CB&Q bridge (completed in 1917) at Metropolis, Illinois, was the largest simple truss ever built. In the 1930s the firm of Ralph Modjeski, Frank Masters, and Clement Chase designed the soaring Huey P. Long cantilever bridge over the Mississippi at New Orleans. At the time it was built it was one of the largest and most expensive bridges constructed.¹⁹ These were landmarks, but they also are typical of what would follow - the age of experimentation was over.



Typical of many small 20th century stations was Circleville on the Erie Railroad. Although built of wood in a relatively standard design, it and countless other stations like it tended to reflect characteristics of the communities they served as well as the nations as a whole.

Much to the contrary were the buildings associated with the operation and maintenance of a railroad. There was similarity in style, but hardly uniformity. Although in construction they were the same as any other industrial or commercial structures, railroad buildings included just about every conceivable type and size, from the single watchman's shanty to immense cathedral-like terminals. Nineteenth and early twentieth century railroading required a tremendous number of structures, far more than we find today. In addition to those with which we are still familiar, there were coaling stations, way stations, mail and express terminals, oil storage houses, oil-mixing houses (besides lubricating, oil was burned for light), water stations, ash pits, ice houses, wood sheds, and countless shanties.

The majority of these buildings were entirely, or in great part, of timber construction. As has been pointed out with wooden bridge construction, fire was an ever-present danger, especially in those structures directly associated with steam locomotives. Engine houses were early users of so-called fire-proof construction.

Cast-iron columns, wrought-iron roof trusses, sheet-iron roofing and siding were all attempts at staving off what seemed to be inevitable. Whitewashing both the interior and exterior not only improved appearances, more importantly, it added a degree of fire retardation to the structure. So great was the concern, some engine houses were designed in such a way as to facilitate the removal of engines in case of fire. It was suggested that they be built with a downgrade to the tracks and that the tracks extend for some distance across an open area in front of the house. If nothing else the engines could be rolled out of harm's way.²⁰

Railroad stations came in all forms, from those designed in-house in a simple, quaint 19th century carpenter Gothic style to the stylish stone edifices that were the work of such well-known architects as Frank Furness and Bradford L. Gilbert. The stations they designed tell us much as they were mirrors of the era and the communities, reflecting affluence and status in their style and decoration. What we see on and around station platforms tell of increasing consumerism, mass produced goods,

communications, and transportation. The need for new passenger stations would decline after the mid-1920s for it was then that the volume of freight and passenger traffic in America would reach its zenith. Future construction would be for replacement and improvement of existing facilities; the economic depression of the 1930s was the end point for rail expansion.²¹ With the passing of the steam locomotive in the 1950s, the myriad buildings and structures associated with their upkeep and maintenance became costly excess.

One of the major elements in 20th century railroading was the construction of a number of monumental terminals. These magnificent edifices, costing many millions of dollars, were literally cathedrals to rail transport and symbolic of railroading's golden age. If we were to cite just one example, the Pennsylvania Railroad would stand as a model. In what was perhaps the largest and most ambitious undertaking ever attempted by a private corporation, the Pennsylvania Railroad Improvement Project lasted from 1902 until 1910. Included in the work was a vast amount of tunnel construction, with sub-aqueous borings under the Hudson

and East rivers, the complete razing of no less than six blocks in the heart of America's largest city, the construction of what can only be described as a terminal of monumental proportions, and the laying out of massive storage yards, all in, around and under New York City.

We have looked briefly at some of the changes made to the landscape in the last 160 years. These changes in the form of bridges and buildings seen in their original settings were examples of individual approaches to solving like problems and stand as symbols of progress. Are these edifices still out there and do they simply go unnoticed? What has become of the cast iron, wrought iron, early steel, and wooden bridges? The majority of the structures are simply gone, having left no artifactual evidence of their presence save for, perhaps, a photograph. Wooden structures and those incorporating wood have always been subject to the vicissitudes of their surroundings and were prone to degradation and early replacement. We might ask, then, what does survive and what is its role today? A surprising number of 19th century stone viaducts remain. Some, like the mighty stone arch Carrollton Viaduct on the B&O in



The world's sole remaining example of a Bollman truss is now an honored relic in a county park at Savage, Maryland.

Baltimore, despite having been constructed in 1829, remain in use. Its effectiveness and that of several other bridges like it is undiminished by time or the evolution of the equipment that passes over it. Stone structures, however, are the exception.

With the 21st century almost at hand, we are led to question what will the structures of the future be like? How well will today's work stand up in time or, for that matter, will it survive? We cannot predict the future, but we can look at the treatment given several structures from the past. This is not done as part of some subtle effort to suggest that we modify our course in anticipation of what will come. Rather, from it we may get a better appreciation of what the future will have at its disposal in dealing with our work.

As we have seen, a number of bridges underwent an evolutionary process, just as other aspects of railroading had. Roebling's great suspension bridge over the Niagara Gorge is an example of how modifications were made in an effort to extend usefulness. Members of its wooden truss were replaced with steel and steel A-frames took the place of the tasteful Egyptian-like limestone towers. But even these changes could not forestall its removal in 1897. What few pieces of the bridge that remain, such as a section of the main cable strand, have become treasured artifacts and are to be found in museums.

The demands of ever heavier and faster equipment, the relocation of rights-of-way, and the abandonment of lines have all been contributing factors responsible for the loss of many fine old examples. It is the rare bridge that can be saved in toto. The one remaining cast iron and wrought iron truss of the three that constituted Richard Osborn's original 1845 bridge now resides in the Smithsonian. A few complete early 19th century examples have been moved and converted to highway use, while fewer yet remain in rail service, invariably on lightly used branches. Some larger examples such as George S. Morison's 1888 long span Nebraska City Bridge over the Missouri River and the cantilever truss across the Hudson at Poughkeepsie, New York, stand abandoned altogether.²² Late in the last century an 1869 Bollman truss was removed by B&O main line service and used to replace an earlier Bollman truss on a not-too-busy industrial spur.

Where being placed in such a location might normally foretell an ignoble end, it was instead quite fortuitous. The siding has long since been abandoned, but the bridge remains. Today it stands as a venerated relic in a county park in Savage, Maryland, for it is the only remaining Bollman truss in the world.

It is the good fortune of buildings that they often can be put to other uses. They, too, face their own set of problems, especially when the ground they occupy is more valuable than the structure itself. On the other hand, when neither the ground is of particular value nor the building of striking significance, a situation of benign neglect is apt to take over. The freight station in Taunton, Massachusetts, is a fairly typical looking Victorian structure completed in 1873. Today, it is a bit long in the tooth, unused, and reduced to anonymity behind a pair of billboards. Perhaps, like Harvey the giant white rabbit who was visible only to Elwood P. Doud, the building isn't actually there. The worst fate that can befall any old railroad structure is that suffered by the monumental Pennsylvania Station in New York City. Constructed as part of the Pennsylvania Railroad's massive expansion project, it stood only until the early 1960s. Progress as seen through the eyes of that time deemed it out of step and not needed. Not the least consideration was the value of the real estate. It was demolished. Almost as if in an effort to completely obliterate all traces of the building, even the magnificent original stone sculptures were not spared and many ended up as fill on the flats in New Jersey. Literally the only parts remaining in place from the original terminal are the stairways and railings leading down to the train platforms and most noticeably—the name.

The situation, however, is not as bleak as it first may seem. Today, unlike the early 1960s, we are more sensitive to our surroundings. We can see that old railroad buildings, unlike old bridges, sometimes can have an afterlife. Through adaptive reuse some have potential as hotels, shops, restaurants and offices. In some U.S. cities older terminals have gone through a renaissance. The terminal at Richmond, Virginia, is now a science museum. The station here in St. Louis is a combined swank hotel and grand mall. After a monumental face lifting, the restored Union Station in the nation's capital still serves its original purpose and has been

revitalized with shops and restaurants. Other smaller examples have become venerated simply because of their beauty and primarily for their relationship to the past. Many of these buildings will remain with us simply because of what they add to our surroundings. The railroad buildings in the paintings of Ranulph Bye transcend the grit and grime one normally associates with the 19th and early 20th century railroading. Taken in this light, these watercolor renderings give a whole new meaning and beauty to railroading which seems to assure us that at least some of the bridges and buildings constructed in the last hundred years might well be with us in the future.

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(Applause)

President Horney: I would like to thank Mr. Worthington for that very informative talk on a lot of history and good information. We have the honor of being invited to the Mercantile Library Association which is located about four blocks from here. At 4:30 this afternoon there is a reception and they have put on an extremely interesting display honoring the B&B Association on its 100th anniversary. I hope everyone has an opportunity to go there to visit with them.

At this time I'd like to turn the program over to Keith Nordlund who will introduce our next speakers.

THE MAGNITUDE AND THE REALITY OF SETTLING ISSUES FACING BOTH RAIL LABOR AND RAIL MANAGEMENT

Tom Watts

Vice President Labor Relations, Union Pacific Railroad

and

Mac Fleming

President, Brotherhood of Maintenance of Way Employees

Mr. Nordlund: Thank you, John. This morning the next special feature on the joint session is on the subject of "The Magnitude and The Reality of Settling Issues Facing Both Rail Labor and Rail Management." We are particularly fortunate today to have the opportunity of hearing the issues from two perspectives both from very knowledgeable and experienced officers. In fact the subject was touched on by Stan McLaughlin in his keynote address. Following the two presentations it's expected there will be a brief time period for questions and answers and we invite you to do that.

We will hear first from Tom Watts, vice president labor relations for the Union Pacific Railroad. Tom joined UP's Kansas Division in 1956 and has held a number of positions in the operating department prior to his present assignment. In 1980 he became director of operations planning and prepared operating plans for the UP-MP-WP merger and presented operating testimony before the Interstate Commerce Commission. In 1982 he was appointed as assistant general superintendent transportation before assignment as general manager intermodal and perishable operations and vice president Union Pacific Motor Freight. Tom was appointed vice president labor relations in 1984 and currently serves as industry representative and chief negotiator on the National Carriers' Conference Committee in national negotiations with all rail labor unions. He is a Sloan Fellow with MIT and holds a Masters of Science degree in business management from that institution. We look forward to hearing from him this morning.

Mr. Watts: Thank you very much, Keith. I am especially happy and proud to be here today and certainly with my friend, Mac Fleming. Mac and I haven't been this close since earlier

this spring when we wrestled together on the floor at the conference committee meetings with maintenance of way over the labor agreements but we're in good shape now and I'm honored to share the podium with Mac. I think actually, you'd be surprised, over how many common issues Mac and I share. We certainly have the same goals in mind which is to preserve as many jobs on the railroad system as we possibly can, while at the same time making our railroads more efficient and as truly competitive as they possibly can be.

I'm also honored to be here today to talk about something as timely as the labor contracts and the current round of negotiations and it's very timely that the 100th anniversary of your fine organization happens to coincide with this labor contract.

Prior to my current position, I worked for over 20 years in the operating department starting in many of the jobs that worked very closely with you and many of your counterparts on Union Pacific, working closely with roadmasters, trackmen, union reps, many of the people that Mac represents today and I personally have a great respect for all of the employees, both labor and management involved in the maintenance-of-way process. I find no higher work ethics nor commitment or level of dedication than in the groups represented here today and the fine members that Mac represents. So again, I am very proud to share this podium with Mac.

I don't think anyone would disagree that job security for any of us does not exist if we are not competent competitively and if we can't compete with trucks and barges. There is no job security without a bigger piece of the transportation market, a healthy bottom line and employees who are committed to serve our

customers and committed to the job at hand. So I don't think Mac or his membership would have any quarrel with that statement. Our disagreements, where we have them, are concerned with methods not the goals. I know right now is an extremely difficult time with the employees you work with each day and that Mac represents as well as other crafts. We have a situation now where negotiated settlements are not going to occur. We have reached settlements with the clerks, the signalmen and the rest of the agreements will be imposed. It's very different than we have had in the past so, consequently, we have a different set of circumstances that I'll talk a little more about and I'm certain that Mac will and perhaps we can cover it to the extent that you wish in the questions.

I've been asked to talk about our labor negotiations today and, in particular, about the agreements we worked out and are continuing to work out. I'd like first to touch on a couple of items that Stan alluded to this morning, which is cooperation and efforts that we have on the Union Pacific. I think it would be incorrect to discuss labor relations in just the terms of an agreement or an imposed contract. We must talk in the terms that our employees can deal with, which is what happens to them every day in their work environment and all of you are aware of that. But we miss it sometimes in the heated environment that we have in negotiating contracts with our counterparts of the other crafts. I might mention first that Mike Walsh, chairman of the UP, has resigned and Dick Davidson, a long-time 30 year railroader has taken over and has committed to all of us that he will stay the course and continue to run the railroad as has been done in the past with the capital, and continue to push real hard for improvements in track structure and to keep our railroad moving forward. I'm convinced that the UP people also share this goal and at all levels they believe firmly in themselves in the ability to produce but they are willing to be measured against, not just the rail industry, but industry in general, both in the U. S. and in other countries. So to achieve that goal at UP we are trying something just a little bit different. I thought I would mention a couple of things that we are working on today.

Currently a quality process is in place and has been ongoing for the last few years to help

identify the causes for failures within our company in everything that we do and to provide teams to look at those failure costs and try to eliminate them by building up teams that guarantee that those deficiencies won't return. We also work very hard on communication that cuts all the way across the very elements of our company in circumstances such as labor management committees which are really groups of people at local terminals. We have some groups all around our system that consist of management and labor and get together to try to solve significant problems at terminals, but they're generally the smaller ones that we might overlook in the general supervision of groups.

A second one is what we call Union Pacific Customer Action Teams where employees in train service, engine service, along with marketing and sales representatives, call themselves on track-side customers to try to find out why it is they are not shipping UP or what we can do to help improve our service to them.

Town hall meetings are something that Mike Walsh and Dick Davidson and others have done where we hop on a plane and go to anyplace on our system of 22,000 miles and talk face to face with employees at all levels at those locations. We take questions; it lasts several hours. We also have satellite hookups. At a recent one we touched almost 10,000 of our employees. We hold formal annual meetings with our general chairmen. All of the department heads enter into the discussion which is primarily a communications effort, and we have over 70 general chairmen on the UP so it's a pretty good sized meeting.

That doesn't mean that we all agree about issues; we certainly don't. We have a lot of things we disagree on. But I think even the disagreements are better, and I've been with the railroad over 30 years, I think our disagreements are more productive than they have been in the past. At least we have a common ground from which to talk.

To give you a couple of examples. We recently closed our Omaha Shop which impacted almost 900 people. We enlisted the aid of the union representatives and many of their people to help figure out the best way to go about that. We transferred a lot of people to other locations and we took bus trips with their employees and their spouses to look over the new work sites. Another illustration is the Katy

merger we just completed where 4,000 or 5,000 people were impacted and we used the same kind of approach by including labor in just about all of our decisions as it related to those moves. That doesn't mean that we agreed on all of them or that it worked perfectly, but I think the disagreements were more wholesome than they had been in the past. Both were very tough, but in both cases the unions pitched in to help.

I guess what I'm getting at is clearly the old adversarial approach that we used in the past is not going to work. It doesn't work and in fact if it ever did work it won't work now. Trucks, barges, other competitive areas, as well as the railroads that each of us interact with, if we're not going to be more competitive we're going to continue to lose traffic. We've turned that around and we have to continue to do so.

So with that as a backdrop let's take a look now at an update on the national and local labor scene. I think to a large degree growth and better service will be the outcome of our national agreement. I think agreement is probably the wrong word to use but everybody has used it so I will too, but as I mentioned earlier these are contracts and they weren't reached in the classical way across the negotiating table. I think right now is as tough a time as I've seen since I've been with our railroad for all of our employees. There's ambiguity coming out of the President's Emergency Board. There's certainly a lot of things that are left up to interpretation. So what I would like to do is just give you an overview of where things stand today starting with industry-wide issues and then narrowing it down to those that apply specifically to maintenance-of-way and B&B employees.

Just a bit about the scope on the conference committee of which I'm a member. We deal with approximately 250,000 people in the industry as well as the health and welfare and pension programs for another 500,000 plus retirees and their families. We deal with a health care plan that's over a billion dollars, one of the largest in the United States. So there's an awfully lot out there that we're working with. The conference committee of which I am a member works with the president of each of the various unions in trying to hammer out the agreements that each of you fine tune locally within your own particular railroads.

Understanding first off that we have no

agreement yet with all the crafts but the two I mentioned we settled with, the clerks and signalmen, and we have no contract language yet to use to implement these agreements, what I'm telling you is my view. I point that out up front of what I think the contract will look like. We should know within the next 30 to 45 days what the language will be from PEB Chairman Harris but what I'm giving to you now, with the exception of a couple of items, is my view.

A couple of things that I can tell you for sure is that the \$2,000 lump sum was paid in July and over the life of the contract there will be 10 percent in general wage increases and 11 percent in lumps. That's 21 percent over three and a half years. A very healthy increase. Some might differ, but I think the reason Chairman Harris did it was to compromise, if you will, the changes in work rules that are inherent in some of the other elements of the agreement. There are stipulations attached to the lump sums that are connected directly to health and welfare. What it says is that up to one and a half of the lump sum can be used to offset up to 25 percent of the increase in health care costs year to year, something that hasn't occurred in our industry before. In addition to that there are changes to a managed care plan, such as a HMO, from the current first dollar coverage. I think you can see in the arrangements, the general idea was to maintain a very quality service in health care at a low cost.

Looking now at specific work groups, I'll just talk briefly about some of the other crafts before we get into one of specific interest to you. For the road crews in the train department as well as the engineers, the basic day historical element of compensation has been changed from the current 108 to 130 miles over the life of the agreement which is 1994. Road yard changes have been made to the extent that flexibility at the initial, the intermediate and the final terminal has been increased significantly as well as the ability to pick up three times at those particular locations. There are waivers that may be granted to serve your customers and to retain old business. I think these will be very important to us in attracting new business to each of the railroads that we serve.

The question of crew consist is a very very large one. While the PEB did not settle the crew consist issue what it did do was set up some parameters by which both parties may be

governed. It said we may negotiate on a local basis until October 31 to reach an agreement to reduce the crew size on trains operating within each of the lines that are party to the national agreement. If an agreement has not been reached by October 31, either party may invoke binding arbitration. In either event the arbitration must be concluded by December 31, 1991. The arbitration decision would be patterned after the Chicago and North Western agreement which includes involuntary and voluntary separations and arbitration over train length, size and work en route. In addition, the BLE, where trainmen receive a productivity fund allowance will be granted over the compensation they currently receive.

For shop craft workers, greater flexibility in rules governing incidental work for all shop craft and backshop employees was included. It can now include simple tasks that don't require either special training or special tools but in that case such work cannot exceed two hours.

Sub-contracting has also been tightened up a bit, for clerks and those covered by the TCU agreement which was really a spin-off of the Wade Study Commission Report that the clerks and carriers jointly agreed upon. We are currently implementing most of that study. It calls for a reduction in the number of job grades. In the past we have had over 1,000 job grades. This reduces it to 15 and reduces bumping and bidding which is very important as many of you know in your clerical ranks that support each view. New rates will be established for each one of these 15 grades. The rates are comparable, not with rail industry, but with outside industry and more closely related to what the workers actually perform as opposed to historical rates of pay.

For signalmen the issues were job security, transfer allowances and training. The job security issue was settled by upgrading Fed. 7 protection a bit to ten years for qualification. The transfer allowance was increased. There was an agreement to establish a form of arbitration disputes committee as well as advanced training. The details have to be worked out by a joint labor management committee.

Now let's get on to maintenance of way and to the areas that concern all of us here in the room today. As I pointed out, we do not have a final agreement with Mac, as yet. I think 45 days will probably see an imposed contract or

at least one that Mac and all of my counterparts will be able to get together on. To me the best way to reach a contract conclusion is by an agreement with the craft that is represented, not by imposed. Where you have arbitration it makes it very difficult for both parties to embrace that decision. I know Mac agrees with this and I certainly agree with it and I hope that labor relations officers represented by each road here today will use that as their mode of operation. We are far better off with agreements that we worked out than imposed contracts.

First with Mac and the people he represents, the \$2,000 has already been paid and three percent general wage increase for this year has been paid and that applies to everyone. Over the life of the agreement, meal and lodging allowances will be increased to a daily max of \$34.75. Beyond the dollar issues I think the most critical areas are with job stabilization. In other words, guaranteeing, if you will, a minimum amount of work. We have tried to approach that with regional gains and, believe it or not, that's the reason that the regional gain flexibility has occurred as a result of the recommendations. It was an effort to stabilize the work force and to provide them with at least six months of work during the year. So they'll be guaranteed, if you will, an opportunity to work for at least six months in return for a flexibility that carriers haven't had in the past on moving the gangs around. A select committee will be organized to study the implementation and that's what is occurring right now.

Sub-contracting is another big issue that remains pretty much the same. In production gangs the day's pay will begin upon arrival at the work site, not when the employee leaves either the outfit car or the motel. Work weeks will gain some flexibility. They will not necessarily be Monday through Friday. For example, a four day week or ten hour days can be possible. Rules on starting times and meal periods are also more flexible. I guess the idea of these changes in maintenance-of-way is to take maximum advantage of the time allowed on the track so that we can be more productive during the peak periods of operation for each of the roads.

There's also an incidental work rule for maintenance of way that is similar to that for shop craft employees. For example, a section

man renewing a grade crossing can handle the planks that used to require a carpenter. A carpenter can do some painting that's incidental to his main work.

I mentioned regional gangs a minute ago and that's the new ability to create the regional or system-wide maintenance gang. The advantages are, I hope, obvious but certainly the flexibility and utilizing the equipment all year and the productivity that we would get for longer periods; and for the employees, a much more stable work environment and a broader work experience. I know this section troubles Mac and his people significantly. I would just like to offer something we've done on UP. We have system gangs that run really all the way from Omaha, Nebraska, out to the west coast. We have had very good luck with those gangs and we have people who continually bid on them every year. I think that, in time, other people and other properties will embrace those kinds of operation and I hope the success that we've had can be used as a pattern for negotiations on other properties. The net of it is we have some very satisfied employees and also I think Stan would say that his people are quite satisfied with their flexibility.

The intent of the PEB in all of these cases is to promote railroad productivity and efficiency while stabilizing the work force. I think that's the common thread, at least in my view, that runs through all these recommendations. Right now, labor and management are doing their best to put this into contract language. But there are some subtle and important differences in how the PEB provisions are dealt with by both parties. The dollar issues, for example, are already in place. They are automatic. They don't require further negotiation: \$2,000 lump sum, 114 miles a day and so on. I think what isn't in there yet are the changes that make us more competitive from a flexibility and operational standpoint. And that's what we're doing now and that is where we need help from each of you, and as Stan indicated earlier, in a progressive way, not in an "Attila the Hun" way so that when we finish the work at hand these changes will be embraced by both labor and management.

I guess that's really where the rub is and I might just talk about that for a second. Labor doesn't like what's happened in this round and I guess we can examine for a moment what's

happened and why they may feel that way. Labor and management tried for six years to reach an agreement on health and welfare. We were unsuccessful. Labor and management tried for two and a half years to reach an agreement on wages and work rules. We were unsuccessful. I think when two or more groups can't get together what you have to do is to provide a neutral, a tie breaker if you will, and that's what was done with the PEB and the special board. It's kind of like being pregnant I guess. It has to go somewhere and something has to happen. In this case the tie breaker was the PEB. The difficulty is the union officials were charged by their membership to maintain the status quo and to come back with large pay increases. I guess some of us weren't sure how we could move the industry ahead if that was what was achieved. I'm not sure how we've moved ahead into the nineties with that logic. I don't fault it that historically that's what the logic has been. I just point out that it seems to me moving into the nineties we need to look differently at the historical relationship that we have had. The PEB was appointed and certainly acted as a neutral throughout. No one got all they wanted. Certainly not management in any way shape or form. So what was the result? Just in a net, the pay changes were quite significant but viewed as less than attractive by labor. The status quo was not maintained. In fact in every craft there are changes in flexibility in work rules that have been recommended. So consequently that's a bad result by labor. It's perceived out in the field as a bad result. I guess the difficulty I have in being very candid about it is when truckers come to me and our marketing counterparts and say that PEB means they are going to have to be a lot more competitive, a lot more cost conscious, a lot more service conscious than they have been in the past because we're going to be more competitive. It seems to me that's attractive for the industry and somehow we have to bring those kinds of elements to the bottom line, but at the same time in a way that means that our employees can also embrace change and work with us to move forward to the next period, the year 2000. I don't think that means that everybody is going to be happy but I think in most labor relations activities compromise is going to be the best thing we can do for the next few years. None of us has the luxury any more of competing in a

regional or even national arena as I mentioned before. It's a global economy and we're in the middle of it. Our life blood is no longer the assembly plant down the road. It's grain to the Far East, it's container shipments from the East to Europe and back. It's consumer goods arriving in Boston, in Baltimore, Portland and Seattle. Buyers and sellers of these cargoes don't care whether we bicker among ourselves. What they care is whether or not we are more efficient, more cost competitive than the truckers that we compete with, whether or not those twin 48s or the triple trailers can beat us from the standpoint of cost and flexibility.

In closing, the security of all of our jobs and our livelihood rests on nothing less than our ability to pull all these diverse issues off and to work together in providing reliable transportation. Our union employees are part of that equation. They must be. They can't forget that. As I said earlier, neither of us can succeed without the effort and informed understanding of the other. It takes communication, it takes cooperation, it takes willingness to compromise. We need to put this difficult round behind us and get on with our work as railroad employees. As partners we must play the hands we've been dealt. The stakes are much too high for either party to fail the other. I thank you very much for your kind invitation and I appreciate the opportunity to be with you. (Applause)

Mr. Nordlund: Thank you, Tom, for your enlightening comments and update on the many and complex issues facing the railways and both the unions and the employees.

The other half of this morning's presentation on the issues facing both rail labor and rail management is presented by Mac Fleming, president of the Brotherhood of Maintenance-of-Way Employees. Mac received his education at Southern Colorado State College and more recently was active in a trade union program at Harvard University. Mac has held a number of positions with the BMWF over a period of 20 years. The first years were spent in increasing levels of union responsibility on the Atchison, Topeka and Santa Fe territory followed by a move to the Detroit office. There he was vice chairman, then general chairman and then was Grand Lodge Secretary/Treasurer for four years. Since September, 1990, Mr. Fleming has been president of the Brotherhood of Maintenance of Way Employees. It is indeed a plea-

sure for me, on behalf of the Associations to welcome you to this conference. Please welcome Mac Fleming.

Mr. Fleming: Thank you, Keith. I appreciate the opportunity to be here with you today to discuss labor and management issues. With roadmasters being close as management employees to the members of BMWF on a day-to-day basis it's important for roadmasters and maintenance-of-way employees to communicate, to meet in settings like this and to understand each other. Working together isn't always easy, though, especially when roadmasters and union employees have different goals in mind.

I was asked to talk to you about the magnitude and reality of settling issues facing both management and labor. To be perfectly honest, reality, today, is unhappy employees. That is especially true among the members of my union. They simply are not happy. Maintenance-of-way employees feel that they have been taken. They see the things that they have struggled for years to obtain, the things that they consider inherent rights, gone, probably forever. They see the boss as a person who has taken it away.

It reminds me of a maintenance-of-way employee, a foreman I used to know, who would meet his roadmaster out on the track each morning to get his daily work assignment. After the foreman got his instructions the roadmaster would disappear and not be seen again until the next morning. The foreman eventually grew tired of the roadmaster just disappearing. He decided that if the boss could do it, so could he. So one morning after receiving his instructions and after the roadmaster again disappeared, the foreman gave those instructions to his assistant foreman and walked off, proud that he had tricked his boss at his own game. Well, it wasn't long before the foreman came running back all out of breath with a shocked look on his face. Naturally his assistant asked what was the matter and the foreman said, "I damned near got caught! The roadmaster was at my house." (Laughter) Now that's an unhappy employee. (Laughter)

That employee feels like he has been cheated out of a relationship he spent years developing and nurturing and to add insult to injury, he has been cheated out of it by his boss. It's not unlike the sentiments of the employees on the railroad today, especially in light of the new

wage package, work rules and health insurance costs they are sharing that just went into effect.

For three years railroad employees sat patiently waiting for a fair contract. A presidential emergency board was appointed to take up the issues and workers hoped the board would come up with a fair solution. In their eyes that didn't happen and, only after all possible opportunities to avoid a walkout were taken, they exercised their right to strike. But Congress stopped the strike, taking away the employees' economic leverage. A special board was established and appointed by the President and workers again put their faith in the system. In reality they had no choice. Just two months ago the special board handed down its mandate upholding all the presidential emergency board recommendations. After more than three years of patient, by-the-book negotiations, after three years of going without a pay increase, the members of my union got very little of what they asked for and they saw many of the things they had worked for in the past taken away. This may sound like bargaining rhetoric but it's not. It's the truth. Perhaps at no time in the history of this industry, certainly not since I've been in the industry, has the work force been so abrasively angry at management. It's a clear reflection of the way things went during the bargaining process that just ended. In the good old days during previous negotiations there was give and take. Neither side got exactly what it wanted. On some issues management gave, on others unions gave. But there was a balance in that no side gave more than the other. There was real give and take, real negotiations. To paraphrase George Bush, "Good will would beget good will." I didn't think I would ever quote him. (Laughter) When the negotiations were over workers and managers were ready to work together, ready to put the confrontation behind them. A handshake meant a lot more back then. Mutual understanding, communication, and positive employee-employer relations were much more common. Unfortunately things aren't the same today. This time labor feels like it was betrayed by the negotiations, like management sat back and waited for Congress and the Bush administration to do its bidding. Management pushed for the presidential emergency board recommendations. We, in rail labor, knew how favorable those recommendations were to management and we

weren't surprised at that move. Of course, management said that the recommendations were awful and they would hurt the railroad industry, but in the same breath, management asked that the recommendations be enforced without so much as one word changed. In doing so, management convinced Congress, it convinced the press and it convinced the public, but management didn't convince its employees and that, ladies and gentlemen, is the problem. It's a problem that each of you will have to deal with day in and day out out there on the track.

Let's talk about the new terms. Employees got a \$2,000 lump sum payment and a three percent wage increase, as Tom previously mentioned. There will be additional lump sum increases and additional general wage increases during the term of the contract expiring in 1995. In all, approximately a 10.3 percent increase in salary.

On the surface that looks great but the underlying fact is that inflation has been averaging about four percent since 1988 when the last contract ended. It doesn't take a genius to figure out that the cost of living will increase faster than salaries. Employee buying power will be 16 percent less in 1994 than it was in 1988 under this contract. On top of that, employees will eventually have to fork out money for the first time for health insurance. Much of that will come from the lump sums I just mentioned. Cost sharing for insurance is not uncommon for workers today, especially as medical costs continue to skyrocket, but it is particularly harsh to make employees give more when they are already losing ground financially.

Then there are the work rule issues. The carriers got every consideration with regard to the work rule issues that were before the special board and the presidential emergency board. In addition, camp cars are now being eliminated on many roads and with job-site reporting, workers will now have to drive hundreds of miles from home to reach motels, then drive additional miles to reach the job site each day.

With seniority districts being expanded workers will be farther and farther from home, wives, children, parents, from little league banquets, and from other important moments in order to drive to work.

My office in Detroit is getting a lot more phone calls from our members these days. The

fear of these new expenses are eating away at them. One member called recently to tell us how it's going to be tough just to afford to work. He said his wallet just can't handle the new travel requirements. Raising a family is getting tougher on the wallet as well.

I am not asking for your sympathy here today. I am simply presenting your problem to you. Management said it needed these changes to become more efficient, and in the wake of the special board report, it got a standing ovation from Wall Street, but let me assure you that it didn't get a standing ovation from within. It didn't get a standing ovation from the men and women who bear the railroad's work, who build them, who maintain them and who operate them. And that's reality. That's what you who work with labor will have to deal with now.

There is no industrial psychologist in the world who will tell you that an unhappy employee makes an efficient employee. It is unfortunate, but management by trying to make its work rules more efficient has made its work force possibly less efficient. When a worker realizes that his or her family will have to sacrifice more because the job doesn't pay enough, that affects the worker. It affects job performance. It affects his ability to concentrate and work safely on the job and an unsafe work force has its own far-reaching ramifications. It also has a natural impact on how he wants to cooperate. If his company won't go the extra mile for him, then why should he go the extra mile for his company.

Indeed, if good will begets good will, what does hard ball beget? There is no incentive or desire today to go the extra mile. Workers will continue to do their jobs and do them well, but it won't be the same spirit that it was before. The will to cooperate, the will to help solve problems, the willingness to go the distance, these are things that are no longer part of the equation. The railroads today face tremendous challenges to compete and employees understand this. We know that unless we can compete we will have no jobs left whatsoever. The railroad industry is, in fact, facing many of the same challenges that the United States faces. Competition from outside is hurting the balance sheet, but if you look at the four most unproductive and uncompetitive years in the country's history you can understand why I fear the

current situation for our industry. Those four years were from 1861 through 1864, during the Civil War. When people are in disagreement with each other they are incapable of devoting their passion to more important goals, to goals like efficiency and productivity. That is why your role is so important. In these negotiations the men and women out there on the front line felt like management didn't even throw them a bone. They felt their work was not appreciated. Their spirits are low. If we are to succeed as an industry, the men and women of rail labor must feel included. They must feel like part of the team, not one of the sides in a civil war. That's not done by patting them on the back, giving them fireside chats about how great they are. Talk is cheap. It's very cheap when you have taken away from their families, their homes, their old living standards and toughened the working conditions.

I could have come here today and sounded themes that are much more pleasant to the ear. I could have ignored the problems that exist but the problems are too great and they are too real and I was asked to discuss reality. I'm not expecting you to rejoice at my words but I do hope you keep them with you as you head back to the roadbed. For the sake of your own railroad and for the sake of the railroad industry and for the sake of all our jobs, if we are to create a more efficient work force and save our industry it will be because of people like you, because of people in management who realize that the only path to an efficient work force is one that not only includes employees in its process but also rewards them properly for their efforts. Thank you very much. (Applause)

Mr. Nordlund: Thank you, Mac, for your very frank and up-front comments stating reality. I mentioned earlier that we were going to give you an opportunity for questions and answers. We are just over the time slot here but we have two top speakers and we certainly lucked out to have them. Are there any questions from the floor that you would like to direct to either Mac or Tom?

Steve Hill, Soo Line: My company, among several others, is negotiating locally rather than on the national level. I would like to have both your opinions on how local settlements, when they come about, may or may not affect the current and future PEB settlements and national negotiations.

Mr. Watts: I don't have a lot to say on that since Union Pacific is in national handling as it relates all the issues with all the crafts, but certainly from a carrier's perspective any agreements that are made on any railroad outside of the national arena, as well as inside, are pattern-setting, precedent-setting and certainly are to be considered in any future agreements that are made. So we shouldn't take any settlement lightly on any property on any subject.

Mr. Fleming: To be frank with you, I think you probably are more fortunate that you are negotiating locally under the current round and under the current circumstances. Certainly most of the carriers in that position realize from the beginning that they may be better off negotiating locally. It's not that I necessarily advocate that negotiating locally is a solution in most of the cases; it all depends upon the circumstances and so forth that you are individually involved with. I'm somewhat familiar with the Soo Line round of negotiations and you don't share a lot of the problems some of the other roads that are included in the current round have. I am also familiar with the tentative settlement in that regard and I have to commend you for the way you approached that, I think it was realistic under the circumstances. I don't think it is going to have very much bearing, though, on what happens with the rest of the negotiations, or not necessarily the negotiations, but clarifications and so forth that remain on PEB 219.

Member: Would either of you care to comment on the court challenge to the PEB? I read something in the trade press that there was a court challenge of that.

Mr. Watts: There's a court challenge by the UTU to the moratorium restrictions that were inherent in current local agreements on crew consists. The UTU served notice against the U. S. government for attempting to usurp those moratorium arrangements. I'm not aware of any suits against other crafts or against other portions of the PEB, I'm only aware of the UTU one. Maybe Mac could respond to that too.

I'll give you an update on where the UTU is. The carriers and labor both filed for declaratory judgment in the circuit court in D. C. Judges have been assigned but I haven't heard anything yet, but we anticipate we will in the next 30 days. I don't know where that's going to go, but what UTU is doing is challenging the U. S.,

Congress, and the President. Whenever I've done that with my taxes I've always lost. But maybe the UTU will do better.

Mr. Fleming: We don't feel, for the most part, that the court is the place to settle these things. Personally, labor doesn't have much success in court. There have been a few federal judges appointed recently who don't like labor. I don't think the court is the place to go. There are mechanisms under PEB 219 and HR 220 to resolve matters. It's not that you won't see any court action necessarily on the part of any of the other crafts. I don't have any comments with regard to the UTU court action and I think Tom pretty well summarized that.

Member: When you're talking about the union members not being happy about all these changes that have been made and they're traveling different distances, has any study been made as to what level you can go to cutting back on benefits, accommodations, traveling, money, whatever, to the point that the men who bid on the gangs cannot work on the gangs any longer? Do you have figures like that when you're doing your bargaining or is it just the men are unhappy because they have to travel? I would welcome your comments on that.

Mr. Fleming: I think, more than anything, the work rules are the basic problem, the changes that potentially could take place. There are a lot of these things that aren't clarified yet. There are a number of issues outstanding that could go either way with regard to work rules issues. For the most part, though, the question as to what happens, for instance, on the region and system gangs, the expansion of seniority districts with regard to increased per diem allowances, that's still up in the air. That's something that's unresolved at this time. Something that's not in the clear from my reading of the PEB recommendations is subsequent clarification and modifications as to what will happen with those issues. I know we have the minimal standards established, the so-called Award 298 that's in the recommendation but, that's part of the problem, part of the unhappiness because of some of the things that are not clear as what was intended. It may well vary from property to property on how that is eventually worked out. I would gather that will be the way it is eventually worked out. Currently CSX and NS are negotiating on some of those issues today. We think prematurely because of

some of the clarifications and so forth that need to be established prior to undertaking serious negotiation.

Mr. Nordlund: Thank you, Mac and Tom, we appreciate your making the effort in preparing for today and presenting your reflections on the future. The road to making a strong unified railway transportation system has always been a tough road but working together, hopefully, we'll reach our common goals. You are both most welcome to sit and relax and enjoy the rest of the conference. I'll now turn the podium over to John Horney.

President Horney: Thank you very much, gentlemen. Our next presentation is on construction productivity by Louis Alfeld with Decision Dynamics. Louis Alfeld received his undergraduate education as an architect at Washington University in St. Louis. After serving two years as an officer in the Corps of Engineers in Europe he received a Master of City Planning degree from M.I.T. and his law degree from Harvard in 1972. In 1977 he was asked to join the National Center for Productivity to organize and direct the Center's construction industry program. He left the Center in 1979 to found his own consulting company, Decision Dynamics, Inc., to apply the principles of performance engineering to large construction projects around the country. In 1990 he received his doctorate in Construction Management from Washington University.

Over the past decade Dr. Alfeld has consulted on dozens of construction sites including nuclear power plants in Georgia and Louisiana, coal-fired plants in Virginia and Florida, petrochemical plants in Canada, an airport in Missouri and east coast commercial projects. One of the projects, the projected 220,000 person community of Palm Coast, Florida, is the largest privately developed community in the

world.

Drawing on his extensive experience, Dr. Alfeld authored "Construction Productivity" published by McGraw-Hill in 1988, a practical management guide for contractors that contains innovative methods now used by thousands of contractors and classrooms across the country. Dr. Alfeld also developed and marketed Job-Sight, an on-site PC-based productivity measurement and job management system for construction. In addition, he developed Over-site, which is a registered trademark, a program for quantifying the cost of delay in construction projects.

Dr. Alfeld has been an affiliated professor at Washington University for eight years where he taught in the construction management program. As a special instructor he conducts an annual three-day construction seminar at the George Washington University in Washington, D.C.

In addition to the accomplishments identified above, Dr. Alfeld has conducted numerous seminars on construction productivity across the country, served as a member of the productivity committee of the building advisory board of the National Academy of Sciences and published numerous articles in the field of construction productivity. He has worked for the National Electrical Contractors Association, The Association of General Contractors, The National Insulation Contractors Association, The National Construction Employers Council and many other industry trade organizations.

Dr. Alfeld is also a principal in the law firm of Alfeld and Gallup where he specializes in computer technology and construction law. He is licensed to practice law in Missouri, Illinois, Massachusetts and the District of Columbia. In addition, he is a registered architect in Missouri and a member of the American Institute of Architects.

CONSTRUCTION PRODUCTIVITY

Louis E. Alfeld, PhD.

Decision Dynamics, Inc.



Louis E. Alfeld

It gives me great pleasure to be here today to address you for several reasons. One of which is this the first opportunity I have ever had to address such a unique organization as yours. As you heard from the intro I spend a lot of time talking to many of the other trade associations and contractor associations across the U. S. and giving seminars at various construction companies, but this is my first opportunity to meet all of you and I'm pleased to be here.

What I have to talk to you about this morning is going to be rather brief and, I hope, challenging because my purpose in coming here today is to spell out for you a very unique challenge for your industry and I hope to paint for you a vision of a way that you may meet that challenge. You've heard the last two speakers talk about some of the problems that are facing your industry in the labor/management issues. You are certainly aware of many of the other problems that you all face. Under capitalization, the need for new capital investment to upgrade equipment and roadbeds. The increasing competition from other forms of transportation, the aging of your infrastructure, the need to replace roadbeds and bridges all across this country. There is a tremendous challenge facing the future of your industry and I think there are many in this country who say, "Why worry about it. Railroads are a thing of the past. Sure they can get bullet trains in Japan and Europe,

but why do we need them here? Why do we need railroads that have old technology and we have better places to put our money." I think the difficulty of raising capital in your industry is an indication of that attitude throughout the country.

I want you to think ahead for a moment beyond the immediate problems that you face day to day, the very serious problems that you grapple with every morning and every evening in trying to keep the industry going and look ahead to a vision of 20, 30 or 40 years from now, what this country will be like, where we are headed and what we are going to be doing about transportation issues in the early decades of the next century. We have been reading reports now for the last 10 or 20 years about the impact of dwindling supplies of oil, on the future of the economy in technology of the world and, particularly of this country. Our country depends on oil more than any other country in the world and we use that oil primarily for transportation. It's the one thing we cannot substitute for. We have coal reserves, we have hydro power, we have nuclear plants, but none of those things are going to move goods and people across the country. Only oil does that now. The most optimistic forecasts that are available today show that the world will be out of oil in 40 years. Forty years is not a long time. I may not be here to see that and some of you here in the room may not be here to see that but some of you will be and all of our children will be. How will the country operate in that future? What will we be doing? How will we move from where we are now to where we will be then? You all are concerned now with the competition posed by cross-country trucking. Cross-country trucking depends on oil just as you do. But the one thing that cross-country trucking does not have is the ability to become super efficient in the use of other forms of energy or of the dwindling supplies of oil and moving goods and people. Only the railroad industry has that potential. One of the visions that I want to give you is to look ahead as to where your industry really will be 30 or 40 years from now and how well it will be positioned to help this country to make a very, very

difficult transition from an oil based economy to an economy where energy comes from other sources, whatever they may be. Now my personal opinion is that the railroad infrastructure in this country will be the key to our survival. It will be absolutely necessary. Unfortunately, we are going through difficult times now and it's unlikely that we'll have leadership in Washington or anywhere else that's going to look ahead that far and say we should start investing now for the needs of the next generation and the generation after that. The only people who are able to carry your industry from where it is today and to position it 10 and 20 years down the road to be able to respond to the new technologies that are going to be needed are you. You all carry a tremendous responsibility for the future welfare of this country. It's a totally different responsibility than almost any other industry in this country faces. If through your industry, actions and inactions, you allow or permit or stand by and watch the railroad infrastructure of this country fall apart to the point where it can't be rebuilt, we're going to be leaving our sons and daughters with irreparable damage and inability to recreate a national economy.

Now with those words of doom and gloom I do not mean to scare you all way. What I mean to do is point out that the day-to-day problems that you all face, real as they may be and as difficult as they may be, are very small compared to what really needs to be done in your industry. And certainly looking beyond the day-to-day, the tomorrows, the issues of what you really need to do is one way to bring the industry together and, hopefully, to bring labor and management together and to bring the leadership of your industry together in building for some more solid future.

Now what I want to offer, and my own specialty is in construction productivity, is only one element of what may be needed for that future. I believe it is an important element for two reasons. One, that it can be done and, two, that it's necessary. What I talk about and what I preach and what I've written about in my book and the word I carry to construction organizations around the country and various contractors that I work with is that productivity in construction has in the past been an easy word. I wouldn't say it's necessarily easy to pronounce for everyone or even to spell, but an

easy concept. It's bandied about and people talk about productivity and efficiency without any real substance behind it. If someone was to ask you to define productivity, you could probably talk about it. You could talk about it at a dinner table conversation, you could talk about it to crews on the road building stuff, but when it comes down to actually dealing with the nuts and bolts of productivity, what is it? What is it really and how do you improve it and what difference does it make?

The work that I have done for the last 15 years or more has been trying to wrestle with that issue of "what is construction productivity and what changes it." One of the conclusions that I have come to and I think I am getting the message across to more and more people is that it's absolutely necessary to define it well enough to be able to measure it. If you can measure productivity, if you can measure daily productivity, if you can measure road gang productivity, if you can measure management productivity, if you can measure it you can begin to do something about it because you know what it is that affects the measures.

Look around at the other things in the economy and in your life that you measure. You measure your personal income, you know whether it is going up or down; you measure the weather, the temperature, we are certainly able, as a country, to measure baseball statistics very well. There are many things we are able to measure, things that mean a lot to us, and it's always surprised me that a lot more effort hasn't gone into such difficult to measure things as productivity but such critical things as productivity. Some of you may be aware of the methods that I've developed. John certainly has been struggling for the past year with some of the concepts that I've developed and that's why he invited me here to talk to all of you. It is the idea that the measurement process itself is not an end all, it's a beginning. It's a way to go about it. The process of measuring productivity is a way of bringing management and labor together by common cause. You can measure productivity almost as a neutral activity and I've tried to develop methods where productivity measurement is not blaming. You don't blame management, you don't blame labor for productivity. You just measure it. Sort of like the weather. We measure it, but unfortunately with the weather we can't do much about it.

There's a lot we can do about productivity.

The techniques that I've been espousing are to start with measures of productivity, cooperative measures used by both management and labor and from there go toward working smarter, not harder, but smarter. I think one of the things that's plaguing labor in this and every other industry is that the pressure to work harder, to somehow produce more per day, with inefficient methods and poor management and I would say, indirection, is always going to upset labor. It makes me upset when I get poor direction and am asked to do things under poor conditions and I'm sure it bothers you, too. The idea of measuring productivity is a cooperative way that both labor and management can look at what it is you are really trying to accomplish. How you do it and how you can improve it so that both sides say, "Yes. That's a better way. Yes. We can do that. We would rather do it this way than that way."

Now as John can tell you from personal experience, any of those of you who pick up my book and take a chance to read it, it's full of little antidotes, about how labor and management can work together in doing this. It gives labor a real voice in what's going on at the job site and for the first time they become empowered in a way that they have never been before in becoming responsible for their own performance. And management becomes responsible for their own performance. You begin to look at what you can do to improve and take responsibility for individual actions. It's not a "we against them". It's not an adversarial relationship. It can be one that's done with extreme cooperation and good will.

I was once working at a coal-fired plant down in Florida and a construction foreman who had been in the business over 30 years came up to me and cornered me and said, "Where was this stuff that you're doing 20 years ago when I really needed it?" He looked around the job site and sort of waved his hand and said, "I've been a member of organized labor for 30 years and we built up all of the wrong things trying to get what we want. If we would have had this sort of stuff 20 years ago we could have had a real organization now. Now this is the last union job that I know of in the state." He was talking about big jobs, the kind that he was doing.

Unions are under incredible pressure

throughout the industry to perform better and they're looking for ways to do it at the same time working smarter for their members rather than harder.

So the message that I leave with you or that I'm trying to get across is that this productivity measurement and productivity management and improvement is a very real way to begin to put together the kind of cooperative organization that can pull together labor and management in an effort that can make some real progress and strides in solving your industry's problems. It's nothing that's going to happen next year. Productivity improvement and productivity measures and all the sorts of stuff I've been preaching aren't going to solve your problems this year or next year. It may not even make a big dent five years from now. But I can promise you this, it'll make a big dent in them 10 years from now and 20 years from now and out beyond when we're really going to need it. If you can build an organization that can pull together the labor, can measure what it is you are doing, can plan effectively, can pull together the best work methods in the country, can tap the intellectual abilities of your work force, the smarts that they have in terms of cooperating and putting together a job in solving problems, you could really have an organization then that can rebuild this country, can rebuild the railroad infrastructure and do it at a price that the country can afford.

What I'm talking about is positioning the industry through this long period of five to ten to fifteen years of difficulty that you're going to go through, in any case, but to come out of that with something that will be able to make a real difference. I don't believe that the way this industry is going you're on that road right now. I don't believe there are many industries in this country that are on that road within the construction field. They are trying to build all sorts of things and we are busy fighting each other. We're busy creating obstacles for each other. We're busy trying to get the last nickel and dime out of next quarter's profit statements. So far the country has not done well in learning from our competitors abroad, that quarterly profits are not the name of the game for those who want to stay in it for very long, that long term growth and stability and expertise and skill and competence, competence, gentlemen, is what counts. We're beginning to learn that as

we face stiffer and stiffer competition from the people in this world that are competent.

So the challenge I give you is to have a more competent industry. To increase the competence of your management, to increase the competence of your labor and increase the ability of both of you to work together. There are no easy solutions to that. There are no simple things that you're going to go back to your office next week and pull out a desk pad and write down one or two lines of key things that are going to solve all your problems. It's an attitude. It's a perspective. It's a change in the way of thinking. It's a change that says, "I've got problems to solve today but what are the long term problems? What am I working toward? What direc-

tion am I going?" Where are we all going?

Now for all of those details, I have a handout paper that I brought with me and I brought along some other stuff, you can read all about the rest of the details in what I've written and done if you're interested in it. But I felt that after listing to the other speakers and with the time available here the most important thing that I could share with you this morning was an effort to get you to think more seriously about this productivity issue and what it really means to your industry and your country. I thank you very much. (Applause)

(Following is Dr. Alfeld's handout)

CONSTRUCTION PRODUCTIVITY

Louis E. Alfeld

Introduction

How important is productivity improvement to your business? What difference does it make if your roadway and bridge projects cost a little more or run a little longer? To most of you, it does make a difference. Productivity matters because you are construction professionals and you want to do the best job you can. Construction managers seek to accomplish a job within time and budget and to do so in a safe and productive manner.

Productivity improvement is a shared goal of all construction managers. Private construction firms cannot stay in business without continually improving. For railroad construction and maintenance work, productivity gains may be even more important — given shrinking resources and expanding work demands, productivity must continually improve just to keep the nation's rail traffic running.

Measuring on-site productivity is one way to start improving it. The purpose of measuring productivity is to discover the causes of productivity change so that corrective actions may be taken. Productivity measures that do not tell you what is wrong and lead you to corrective actions wastes both time and money. Conversely, measures that indicate when and where to act pay back their costs many times over.

Productivity and Measures of Accomplishment

On-site construction productivity depends on:

- systematic planning before construction starts
- detailed monitoring of construction in progress
- regular feedback of results to ensure continual improvement in all areas of job planning and control

Why are these three requirements so important? Many professionals in the construction business pride themselves on their ability to plan a job. But the complexity of most jobs requires an interlinking of many plans. Even your most careful plans will come to nothing if they do not mesh with the plans of others. Systematic planning is necessary so that all plans fit together and nothing is left out.

Many companies take special pains to monitor the progress of their jobs. Computers process detailed data on hours, costs, schedules, and materials. But does this information measure the productivity of each construction activity? Unless it does, it only tells you what happened on the job, not why it happened and what to do to correct the problems. Productivity measures must be a central part of your job monitoring.

Although many companies may do well at planning and monitoring, few provide adequate feedback. Feedback is the information that tells you how well you did in planning and building the project. Ideally, feedback should reach everyone connected with a project. Feedback is a "report card" telling you how your contribution affects productivity. Yet because most productivity information is inaccurate, incomplete, and late, such "report cards" are neither widely used nor very useful.

Monitoring On-site Productivity

The feedback that planners (and all project supervisory personnel) need comes from careful monitoring of on-site productivity. This means measurement. So how do you measure construction productivity?

First, you must recognize that the purpose in measuring your productivity should be to discover the causes of productivity change. Improvement starts with measurement. You measure your productivity to find out what affects it. When you know what affects productivity, you can take effective actions to improve it.

How much detail you measure will vary with the job. The measures you need will depend on (1) your ability to use the information and (2) the cost of collecting and processing it. There are jobs where the only information management gets is a weekly phone call from the site saying "everything's okay"—when it isn't. And there are jobs with thick stacks of computer printouts that no one looks at. Too much detail can be just as useless as too little. Good measures give you just enough detail to spot the problems that deserve your attention—and no more.

In addition, good measures should give you the information on time. It doesn't help to discover the job was in trouble four weeks ago. Late information makes it hard to find out what caused the problem. Late information also misses the time when the simple solution would have worked.

Unit Rate Measurements

Unit rates give measures in manhours per installed item or quantity. Unit costs measure dollars per installed item. Such unit measures

provide the most objective and most direct measure of construction productivity. Contractors often collect unit cost measures to use in estimating later jobs. While unit rate or cost measures sound good, they are usually hard to get, inaccurate, incomplete and late. You can overcome these problems if you design your measurement system with the needs of the job-site in mind. The problems arise because most unit cost systems are designed by accountants and estimators to meet their needs, not the needs of the project management.

Unit costs measure the installed cost of an item—materials, labor, and equipment; but they do not measure productivity. Low productivity rates help hold costs down. However, soaring materials prices, wage rates, or equipment fees will drive unit costs up despite good productivity rates.

Monitoring unit costs gives important information on management performances and job costs. It also helps with estimating and bidding. But it does not measure productivity nor do changes in unit costs always pinpoint productivity problems and what to do about them. So, always use measures of unit rates to manage productivity.

Unit rates have their problems as well. The numbers are frequently hard to set, inaccurate, incomplete, and late. Most of these problems arise because the measurement systems were designed primarily to support the estimating and accounting departments, not the on-site project manager. Most of these systems measure costs, not rates.

In some larger firms, computers run unit cost data reports and feed them back to the job. Reports may also include comparisons between work actually done and the schedule, between actual and estimated costs, and between percent complete and percent expended. All too often such reports weigh several pounds, contain too much detail and serve as dust-catchers in out-of-the-way corners. And the information, even if it is readable, arrives too late to really affect project decision-making.

Lost Time Reporting

Accuracy is always a problem. If counts of installed units and manhours are not right, what good are they? Yet foremen will bury their crews' "slack time" in those items that can

"afford" it. Slack time due to waiting for materials, equipment or directions is really lost to the job. Yet it gets averaged into the unit costs. When unit costs include the lost time depends on how the foremen want it to come out. This means that your unit costs can vary widely from week to week and so be worthless for tracking and trouble-shooting short-term job performance.

Useful unit cost measures must separate actual work time from the inevitable lost time. Unit rates could then be figured only on the time that was really spent doing the work. Excluding lost times gives you a true unit rate for each activity. Following changes in unit rates gives you the information you need to find the problems. Weekly monitoring of such rates gives management the information needed to intervene exactly in those work areas where there are problems. Management can concentrate on reducing lost time by eliminating the problems that cause it. And tracking lost time lets you see what the mistakes really cost. Once you see the costs, you will have all the incentive you need to get rid of the problems that cause lost time.

An example of a productivity management system that separates lost time from work time is described in my book, "Construction Productivity". John Horney is currently developing a measurement and reporting system patterned along the book's guidelines. It uses a simple time and materials accounting method to generate weekly feedback reports. The reports can be tailored to each level of job management (including foremen). Each report will put all of the "red flags" on a single page and point management directly at the sources of the problems. Such a system, by providing direct feedback from the field, places responsibility for productivity directly on those able to improve it, you, the management.

Labor Time Reporting

Lost time can be reported directly by foremen on the daily labor time sheet reports. The use of a lost time code allows foremen to charge their unproductive time directly to management overhead. It is then up to management to do something about it.

If you opt for a unit rate measurement system, you will not be able to cover every

work activity. Some activities (such as clean-up) defy unit rate measures. Yet be sure to put all of your payroll hours through the system anyway. This keeps track of the percentage of time in each activity even if every activity does not have a measured rate.

You can probably modify your present labor hours and in-place work reporting to get more accurate counts of actual unit rates. But do count on spending enough time and money to do it right. These start-up costs can be high. Once in place, however, the benefits of increased job control can quickly pay back your investment. You will know exactly what your productivity is and what to do to keep improving it.

Timely Information

To manage well, you need a great deal of information, not just productivity reports. Most managers recognize this and seek as much as possible. Sometimes, however, they wind up with too much information and become inundated in it. As a result, management performance suffers.

More important than the quantity of information you get is its quality. Good decision-making depends on such information. This means that the information must be accurate, complete, and, because construction jobs move rapidly, it must be on time.

Unfortunately, a trade-off exists among these three aspects of information when it comes to productivity. Current productivity information, particularly on a construction job, generally contains inaccuracies and is seldom complete. On the other hand, by the time all the information is compiled and cross-checked to be sure that it is correct, it is too late to do much about it.

Many contractors choose accuracy and completeness of timeliness. Payroll, personnel, data processing, accounting, and estimating all require accurate and complete information. By the time everything is run through the home office computer, it may arrive in the field four to six weeks after the information was first reported. In one month, many things happen on a construction job; so, the information that is sent back is rarely useful.

Productivity management demands timely information. Accuracy and completeness count

for less than getting the information back to the field on a timely basis for people to act on while the problems are still fresh. Productivity measures must provide data to the people who can improve performance; for this, the information must be current.

Management Actions

Productivity describes a relationship between what you put into a job and what you get out as a finished product. We have discussed measuring productivity in terms of lost time and manhours per installed item to arrive at a unit rate. But the manhours spent on the job and the amount of work accomplished reflect not only the productivity of the labor force but also the productivity of management. Good unit rates depend on good management—the bringing together of the right tools, equipment, materials and people to get the job done in the most efficient manner.

Since variations in on-site productivity depends far more on the things management does, or fails to do, than on the labor force, let us think of productivity as a measure of management effectiveness. The four hallmarks of effectiveness are standards, feedback, reinforcement and job support.

Set Performance Standards

To get the performance you want, you must first set the standards you expect everyone to meet. No one can consistently perform well if they do not know what good performance is.

If you lack clear standards, getting them set should be your first priority. And it costs you next to nothing to do. Start with two primary activities: weekly targets and work productivity. For each, list the standards you want everyone to meet. In developing your standards, ask yourself what standards, if they were all met, would insure a great job. For example, what targets must you hit to meet the schedule? And how many manhours will it take to hit those targets?

In setting manhour targets, however, be careful not to set standards that put a ceiling on how much your work force can accomplish. Rather, set standards based on exceeding the targets met by the last job. Manhour targets also can cause problems when applied to differing types

of work. One contractor, based on installing a half-dozen types of supports, found it hard to tell which crews were performing well since the manhours varied so much among supports. He solved the problem by asking the crew foremen to come up with equivalent rates for the supports—so many of type “A” equaled so many of type “B” equaled so many of type “C,” etc. Crews were then assigned equal workloads based on the foremen’s weighted rankings.

Provide Feedback

Having standards will not help unless people know how well they are doing against the standards.

The best feedback tells individuals or crews how well they have performed against the standards. Such information as work done for the week compared to the target for the week, and manhours expended on a task compared to estimated manhours, provides specific measures of performance. How much detail you include depends on the type of job and your capacity to pull that information together.

Although any feedback is better than none, giving feedback about poor work rather than good work can actually undermine motivation. Praise, not criticism, is the stronger management tool. How much positive feedback do you now give your field supervisors?

Think about the amount and type of information that reaches your lower levels of field supervision. On a construction project, the people at the bottom often feel left out because no one ever tells them how the job is going. Weekly reports on progress provide one regular means of giving feedback. Weekly reports may be either oral or written, but written reports, provided they are timely, tend to have far greater impact.

Reinforce Good Performance

Besides knowing how well they do, your work force needs reinforcement to continue to do well. Sure, you pay them, but what else motivates a person to perform well? Constant use of “negative reinforcement”—criticism—often produces only mediocre performance.

Stress the positive reinforcers—the things that make an individual feel good about participating on the job. Put yourself in the shoes of

one of your foremen: what would reinforce your good performance? If you did an outstanding job this week, what would encourage you to try to do even better next week? Maybe the strongest and least expensive reinforcer is simply to tell the individual that you know about that good performance and that you appreciate it.

Surveys of work job satisfaction at various construction sites have tended to show that wages, high as they may be, are not a strong reinforcer for good work. Stronger reinforcers tend to be those that make workers feel they are important to the job, that their time is valuable to you and that their ideas are listened to. How can you get your work force more involved in the project so they see that their contribution counts? Identify rewards, even small ones, that acknowledge good performance and use them regularly.

Remove Task Interference

How well did you support your people in the field? Management must take responsibility for removing all of the interferences that slow the job down. Weekly meetings can be used to find problems and plan to avoid them in the future. Material, tool, and equipment needs can be watched to make sure the work crews have what they need to do the job. You can involve the work force in finding better ways to do the job. Ask your foremen for their ideas—where time is lost, what work is out of sequence and what work methods might be improved. The person with the tools knows more about task interference than anyone else out there. Keep the jobsite in close touch with the home office to provide quick turnaround on decisions that require top management judgement.

Remember, interference comes not only from

things that directly get in the way—scaffolding, other works or confusing directions—but also from things that aren't there but should be—clear plans, materials, and timely decisions. You can't eliminate all the interference from every construction task but you can get rid of a lot of it if you look for it.

Conclusion

Productivity improvement is a tremendous challenge, but it can be done. It requires a serious effort in learning to measure productivity and to report those measures in a way that provides useful information to management. It also requires a serious management commitment to accepting responsibility for productivity improvement rather than merely talking about it. The actions needed are not difficult, but they do require patience and cooperation and, perhaps most of all, a willingness to persist in the face of those obstacles to change that will inevitably arise to test your dedication to long-term productivity improvement.

President Horney: Dr. Alfeld, I thank you very much for your time to be with us today. I would like to thank all of this morning's speakers for taking the time to share with us this morning.

Before we adjourn this session I would like to ask you all to pick up a special committee report sheet. The B&B sheet is orange and the Roadmasters is blue. I ask that you fill these out and turn them in at the registration desk because these subject cards are the foundation for the topics that will be used at next year's conference. The B&B session will reconvene at 1:30 p.m. in the Ballroom F and G and the Roadmasters will reconvene at 1:30 right here. This session is adjourned for lunch.

MONDAY AFTERNOON SESSION

September 23, 1991



John Horney

President Horney: I would like to declare this afternoon's session of the B&B Association in session.

It's been a year now that I've been president and I'm just about to turn it over to Mark Walbrun. It's been an exciting year. This being our centennial anniversary we were involved with several functions. One I hope you have taken advantage of is down the hall. We have set up a room with displays depicting our 100 years of existence. It's very interesting and if you have a chance, stop in there.

While I was working with Wally Sturm, chairman of our centennial committee, we came up with several interesting facts. One of those was that 50 years ago, in observance of the B&B's 50th anniversary, a fellow named Clarence R. Knowles wrote up a summary of

the Association's existence to that date. He pointed out that "although we can well be proud of the work of the Association and the position that it occupies in the railway field today, our work is not finished. It has hardly begun. Although progress and development during our 50 years of existence have been remarkable, they are but little as compared with what we may expect in the future. The coming years promise even more and more progress with which we must keep pace if we are to keep up with the procession of time. We have little to fear, however, if we follow the same spirit of loyalty and devotion to duty which has been the outstanding characteristics of the membership of this Association the last 50 years." I don't think better words could be written today than what was written 50 years ago. With technology changing as it is, it's more important today that we, as an Association, continue to work together and share our experience and knowledge for the betterment of the Association. I hope that my year as president has helped contribute to that and you, as members of the Association, will continue with this goal and that the next 50 years and 100 years continue to be as exciting as the last 100 years have been.

At this time I would like to turn the program over to Paul Saletnik who will introduce this afternoon's first presentation. Paul.

Mr. Saletnik: Thank you, John. Our first presentation this afternoon will be on "Truss Reinforcement on Bridge No. 208" by Dave Cook, B&B supervisor of Montana Rail Link. Mr. Cook received his Associate Arts Degree from Diablo Valley College in Pleasant Hill, California, and worked for the Burlington Northern from 1972 to 1987 when he assumed his present position with Montana Rail Link. Dave.

MONTANA RAIL LINK BRIDGE NO. 208 REHABILITATION PROJECT

Dave Cook

B&B Supervisor
Montana Rail Link



Dave Cook

Background

Bridge 208 lies on the Clark Fork River between St. Regis and Paradise. This bridge was constructed in 1908 by the Northern Pacific Railroad. It is a six span bridge, 543 feet long consisting of two 60-foot deck plate girder approach spans on each end, and two 150-foot trusses. Bridge 208 had been rated 184 tons by the Northern Pacific standard or equivalent to E-62 Cooper's loading.

Problems with 208 were noted as early as 1954 when the top lateral bracing of the truss started cracking and breaking and repairs were made by replacing them. These same repairs were again made in 1976 by welding the cross bracing in place.

In 1980 it was also noted that the expansion bearings had not been performing and were frozen in the expanded state.

In 1985 the bridge started experiencing broken rivets at the floor beam to stringer connection angles and at the floor beam to top cord connection locations. In the time period from 1985 to 1989 crews replaced broken rivets and

broken bolts at those same locations consistently, amounting to two to three months of work per year.

In 1988 Montana Rail Link elected to rehabilitate Bridge 208 due to the deteriorated state of the cross bracing, stringer to floor beam connections, top cord to floor beam connections, and general condition of the floor system. It was also decided at that time to replace the open deck with a precast prestressed composite ballast deck.

Rehabilitation Theme

The scope of the work was to include the following in the rehabilitation process:

1. Installation of additional vertical stiffeners to increase deck plate girder capacity.
2. Reinforcement of columns at piers 2 and 6.
3. Enlarge the cap surface at piers 3 and 5 to accommodate the new tower and additional arch bearings.
4. Install tower frames at 3 and 5.
5. Installation of new expansion bearings throughout the bridge.
6. Installation of the tied arch system for reinforcement of the deck trusses.
7. Removal of the existing truss floor system from the top cord up and replacing it with a new floor system including a composite ballast deck.
8. Removal of an open deck system on the approach spans and replacing it with a composite ballast deck.
9. Flame straightening and shortening of loose I bars.
10. Installation of ballast retainers at both abutments to accommodate the 18 inch top of rail raise.

The Work

The rehabilitation process started in the spring of 1989 by jacking up the truss and replacing the expansion bearings at pier 4 location. A temporary support system was installed to handle the load of the truss during cure of the



new concrete foundation for the new bronze lube light bearings assembly. Concurrently vertical stiffeners were added to the deck plate girders of the approach spans requiring field drilling of the web. Seven thousands pounds of steel was added to the approach spans. Work then commenced on enlarging the pier tops of piers 3 and 5 to accommodate the support area required by the new tower frames and the arch support systems. During this process we engaged and used a cantilever jacking system that was attached to the existing pier. The jacks supported not only the concrete but also the staging system. The jacks were placed on two foot spacing around the perimeter of the pier. From that point upward, typical construction methods were used. After completion of the sandblasting of the existing pier tops, drilling of the holes for the rebar, epoxying the rebar in the holes, and installing the forms, the prep work for the 40 cubic yards of concrete for each pier was done. The concrete was placed utilizing a locomotive crane and one and one-half yard bucket.

To do the work on the column reinforcements at piers 2 and 6, we used conventional methods of adding a stiffener plate to the web of the columns.

Field drilling again was required for each hole. Throughout the bridge project we used the hole saw method of drilling. This cut our drilling time from approximately three minutes per hole down to approximately ten seconds per hole for a nominal one-half to three-fourths inch depth of drilling. A normal twist bit requires sharpening on or about the 20th hole drilled. However, we were getting between 350 and 500 holes per bit before sharpening, depending on what brand of bit we used. This drastically reduced the time and expense of drilling holes.

Concurrently with our work at piers 2, 3, 5, and 6, we also started heat shrinking the I bars, reducing the extreme looseness of existing bars. This put the truss in a more stable condition. Not being real familiar with the I bar shrinking process, we used the AREA procedure but reduced the temperature ranges from 1800 degrees to 1300 degrees. The heat shrinking required between four and eight heats to shrink I bars one-half to one inch in length. Most individual heats gained one-fourth inch while occasionally one-half inch was noted. After some of

the more difficult to reach I bar locations were completed, we started the installation of our tied arch system. The arch system required over 7,000 bolt connections of both the seven-eighths inch and three-fourths inch variety and 201,000 pounds of steel was added to the bridge trusses by adding the arches. The main arch system was provided in six pieces per cord which surround the existing cords on the north and the south side of each truss. These three arch members would be affixed to the vertical post members at each panel location on each side of each truss.

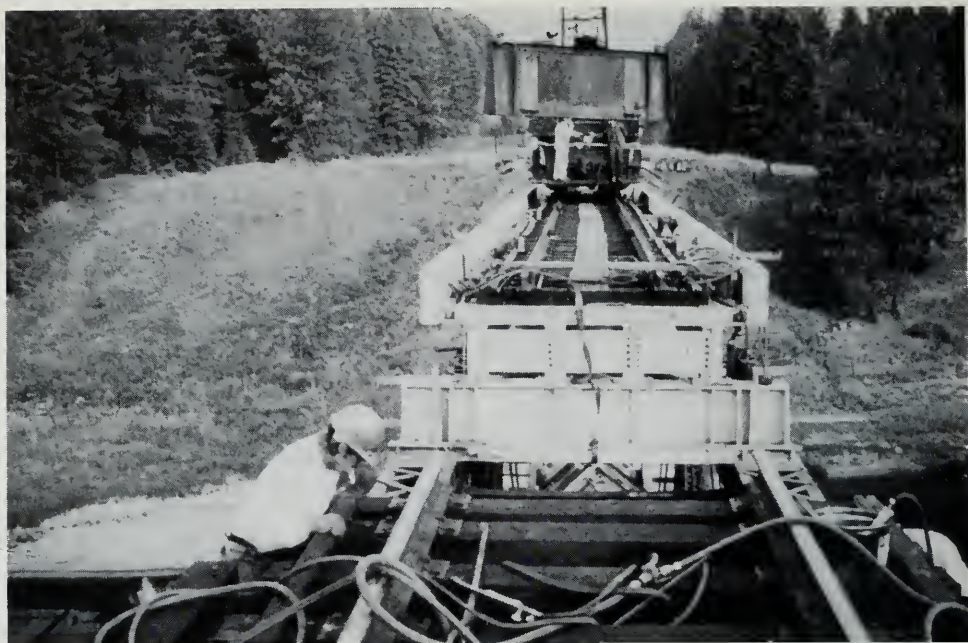
Shop fabrication provided for all holes to be pre-drilled in the arch system with the exception of the final attachment to the truss post members. It was felt that we could not achieve an exact location for each one of these attachments through measuring because of slight error in fabrication or truss adjustments. These holes were field drilled at the time of placement which eliminated elongated holes because reaming may have been required.

At the completion of the arch itself, one and one-eighth inch diameter DYWIDAG bars were strung at approximately the same horizontal location as the bottom cord. These bars tied the ends of the arch together to form a tied arch system. This was required for post tensioning at the time of completion of the arch construction. These arch DYWIDAG members were post tensioned twice, once at the completion of the arch itself, and then again at the end of the job.

The installation of the arches and all the work previous to this were completed with minimal delay of train operations. We were able to complete most items with very small train free windows, not having to request special time allotments for the work.

Vertical cross bracing was also scheduled for replacement which required large amounts of scaffolding. A total of 21,000 pounds of steel cross bracing was replaced. We worked more than one location at a time to speed up this process. We could only disassemble the bottom half or the top half of the vertical cross bracing at a time and still maintain traffic.

Fill-in work for us included removal of over 13,000 rivets in the existing floor system and temporarily installing bolt fasteners. This was done to expedite floor system removal and replacement, cutting down on the required train free time needed on the days of the floor sys-



tem replacement.

During the 1989 work season we had accomplished the installation of the arch, the substructure work, new bearings, vertical reinforcement of columns 2 and 6, and tower span installations. Due to the lateness of the year, the remainder of the work was postponed until the 1990 season.

Plans required a total of an 18 inch top of rail elevation raise to accommodate the new floor system and ballast deck. Phase I would account for 10 inches of the 18 inches required. This was the nominal thickness of the concrete ballast deck system. After careful planning we pre-built panelized track sections to the exact lengths that would be required for a day's work. These panels were about 26 feet long.

Every day was planned in 15 different sequences. After all track panels were pre-assembled, we raised track on both approaches to the bridge, took the rail and tie plates off the existing bridge ties and installed the track panels on top, bolting them down to secure them. This raise gave us the required 10 inches for Phase I. As each day progressed we would be able to remove the track panel, the bridge ties, do the work on the steel, and replace it with prestressed precast concrete ballast boxes. We then reinstalled the track panel and set it direct-

ly on the floor of the ballast box. Ballast would be placed after the entire deck was completed and the track then raised.

To achieve our goal of composite action, the work on the approach spans would be done as follows:

I. Removal of the track panels, bridge ties, and associated hardware.

II. Removal of scale and paint from the top flanges of the deck plate girder. By sand-blasting we were able to prepare a surface for the welding of the sheer studs.

III. Installation of evastoe and durometer pads to provide a temporary resting and form system for the precast panels.

IV. Setting the precasted concrete panels.

V. Welding the Nelson studs to the top flange of the girder through the holes provided in the precast concrete panels.

VI. Post tension the prestressed precasted panels together to 90 kip by the use of DYWIDAG bars.

VII. Placement of grout in the holes where the Nelson studs were welded.

VIII. Reinstall the track panel. The panel was secured to the ballast box by bolting the ties of the track panel to a threaded insert provided for in the precast ballast box. This maintained proper alignment until the ballast was added

after completion.

By utilizing couplers for the DYWIDAG bars, we were able to post tension each additional slab to the one previous and ultimately have each span length post-tensioned to 90 kip. This provided us with the composite action after the grout had been poured and had cured. The grout flowed between pockets in the space provided by the durometer and evasote placed between the top flange and precast concrete ballast box. The grout in the pocket itself, along with the welded shear studs, provided for the composite action. In filling the grout pockets, a continuous grout base was provided.

A fast action grout, designed to achieve 3,000 pounds per square inch with a nominal four hour set time, was used. Knowing that short cure time was critical to our train free windows, we chose a Portland based cement grout. After a vigorous testing program, we concluded that only a three-eighths inch minus clean, sound, natural aggregate, using only the minimum water to cement ratio allowed requiring a paddle wheel type mixer, would consistently produce our desired results. A volume of 50,000 pounds of grout was used.

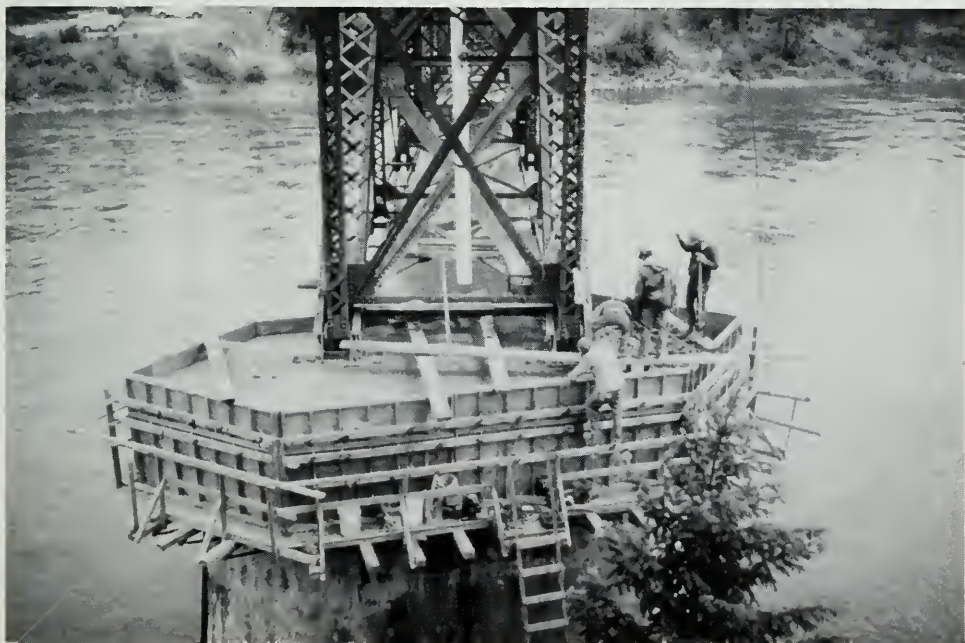
Each day that concrete was poured, test cylinders were also taken and after the test cylinder strengths were achieved, traffic was allowed to resume. Requirements for train free

windows started with 12 hour time frames and as our learning curve increased we were able to accomplish the work in nine to ten hours. Two to three precast concrete panels were installed each day on the approach spans.

After completion of both of the east approach spans, the day came when the transition had to be made between the deck plate girders and the truss. In one day we had to remove eight stiffeners on both girder flanges, remove the fill plates, reinstall the cantilevered fill plates, reinstall the end stiffeners, install the new cap, install the first floor beam on the top cord of the existing truss, install the stringer system, set the precast, prestressed concrete ballast deck slabs and reinstall the track. This initial jump span required a 20 hour window.

We then proceeded with the replacement of the existing floor system of the truss every other day with train-free windows of 10 to 12 hours each. Over 201,000 pounds of steel was replaced for the new floor system. The work included:

1. Disassembly of the installed temporary bolts, stripping the bridge down to the top cord, sandblasting and zinc priming all covered locations for the new gusset plates and bearing areas of the new floor beams.
2. Installation of the new floor beams, attaching them to the top cord of the truss.





3. Setting the evasote and durometer forms on top of the new stringers.

4. Installation of the new stringer system. (Note: the sheer stubs were prewelded on the stringers).

5. Installation of two precast prestressed panels of ballast boxes.

6. Post tensioning of the ballast boxes with DYWIDAG.

7. Grouting the ballast boxes.

8. Installation of track panel.

A temporary floor system had to be prepared for each day's connection between the new floor system and the existing floor system. Considerations had to be made for temporarily holding the existing stringers of the old floor system in place while the floor beam was removed and replaced with its new style floor beam. The existing stringers were end framed to the floor beams and the new stringers set on top of the new floor beams. This required torch cutting the existing stringer for floor beam removal. A temporary diaphragm was attached to the old stringers which required field drilling of the stringers and bolting a new bearing area to set on the new floor beam.

Our train-free windows were carefully planned to efficiently utilize the time. We specialized people in each discipline to minimize learning curves. For instance, there were two

people on a team and each team had a specific purpose for each day's window.

Some of the work needed more than two people to accomplish and as teams were completed with their phase of the work, they were grouped with the teams that needed help. Examples of areas where specialized teams were used are:

1. Disassembly of the existing bridge.
2. Temporary floor beam and diaphragm installation.
3. Welding the sheer studs.
4. Installing the evasote, durometer and mastic.
5. Preparing and delivering the grout.
6. Setting the stringers.
7. Post tensioning of the paneled ballast boxes.

We were able to reduce our train free window requirements from 12 hours to 10 hours as the project progressed. As the project neared completion, the walkway was installed. A day was required to unbolt the track panels from the inserts provided in the ballast boxes, dump the ballast, and raise the track section throughout the entire bridge, including the approaches to the bridge. This raise gave us the final eight inches of raise across the bridge. Post tensioning once again occurred at the tied arch system to accommodate for the additional loading of

the new ballast deck.

Conclusion

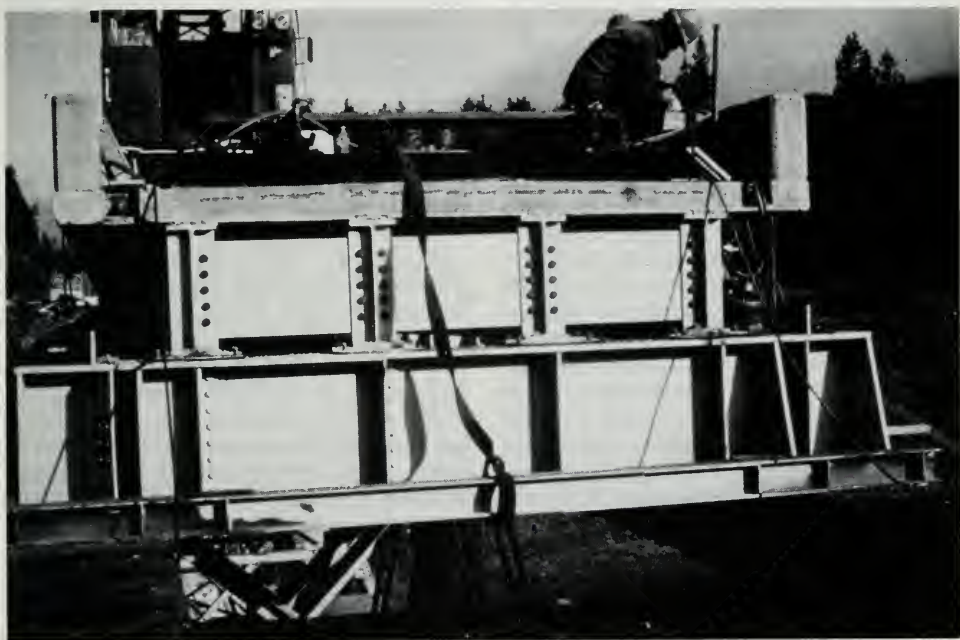
The rehabilitation process for Bridge 208 utilized over 500,000 pounds of new steel, 50,000 pounds of grout and 44 precast prestressed ballast boxes giving us an arch reinforced set of trusses with a composite ballast deck and reinforced approach spans composite with the ballast deck.

All the work was done with Montana Rail Link bridge crews. One crew consisting of eight men was assigned to the bridge during its entire rehabilitation while another crew consisting of five men was added for approximately a three-month period. The project work took nine months in 1989 and three months in 1990 to

complete, with a rehabilitation cost of \$1.3 million, substantially less than the estimated cost of the total bridge replacement. We will benefit many years of additional service from this bridge. Thank you. (Applause)

Mr. Saletnik: Dave, thank you very much for a very informative presentation. I would now like to call Johnny Bradley up to the podium to introduce our first special subject.

Mr. Bradley: Special Subject No. 1 is "Upgrading and Extending the Life of Timber Trestles". The report will be given by Ronald Kaye who is the senior project engineer of structures with the EJ&E Railway. He received his B.S. Degree from the United States Coast Guard Academy and his master's at the University of Illinois. Ron.



UPGRADING AND EXTENDING THE LIFE OF TIMBER TRETTLES

Ronald W. Kaye

**Senior Project Engineer
Elgin, Joliet and Eastern Railway**

I have nothing new or dramatic to offer you today. I have no miracle cures for your timber structures, and I can't make them go away for you. Often today we only think of timber bridges as "temporary" structures. Perhaps we should look again. Timber bridges are still relatively inexpensive. They are capable of handling heavy railroad loadings and they can provide a long service.

Far from being a thing of the past, timber trestles are still an essential part of the North American rail network. In some cases timber trestles remain in service because funds aren't available to replace them with concrete or steel. In most cases though, timber trestles are still in service because they are more economical than the alternatives.

Several years ago Committee Seven of the AREA published some interesting statistics in their report on "Current Design Practices of the Railroad Timber Trestle". Of the Class I railroads for which they compiled information, on average, timber trestles accounted for 43 percent of their bridges. The information I gathered indicated that these statistics are still representative. Regardless of whose numbers you look at, timber trestles constitute a significant percentage of the total railroad bridges in service today. Over the past few years we have seen a number of timber trestles dropped from the inventories of Class I railroads as they sell off unprofitable or marginally profitable branch lines. Many of these bridges, though, are still in operation, providing indispensable service to the short line railroads that now operate these lines. Although they have gotten rid of a few, the Class I railroads still have a significant number of timber bridges on both their main lines and branches.

Timber railroad bridges in service are typically 50 to 70 years old. With proper inspection, maintenance and treating they can continue to serve the rail industry for many years to come.

The basic design of timber trestles has not changed much in the past 100 years. The driven pile bent and the framed bent construction of the past are still in use today. The sizes and number of piles, stringers, and pile caps have been increased to keep pace with the increasing loadings from faster and heavier trains. By the 1890s there was already a strong push to replace timber bridges because of their limited life span with more "permanent" concrete or steel structures. One hundred years ago the expected service life of a timber bridge was only about seven to ten years before replacement or major repairs were required. With the advancement in preservatives and pressure treating methods we have seen a dramatic increase in the expected service life of timber bridges.

We have made many improvements and learned a lot about how to preserve our timber structures, but we may have lost some things along the way. During the late 1800s, railroads built timber bridges of all sorts: truss bridges as well as trestles. These were typically built by craftsmen, who used carefully constructed joints. Where today we fill poorly fitted joints and bearings with epoxy or other material, the craftsmen of the past took the time to ensure a tight timber to timber fit; workmanship the builder could take pride in. The quality of timber available 100 years ago was far superior to today. Large straight timbers were readily available in most of North America. Today we have come to accept minor defects as standard. We are also willing to settle for lower grade timbers because in many areas higher stress grades are no longer reasonably available. The chemical process used to speed timber growth increases the spacing of growth rings, reducing the structural capacity of newer timber. When we need larger timbers the supplier goes out to the woods to see if they have a tree that can fill our order, instead of into the storage yard. The required lead time for quality timbers is getting longer each year.

It is important that any bridge repair project be carefully planned in advance. With the long lead time for timbers and the difficulty in accessing the structure's integrity, this is perhaps even more important for timber trestles. A full inspection of a timber trestle is advisable before beginning a repair project. The actual condition of the entire structure must be known before you can determine the extent of repairs required and the most economical solution. Make sure the extent of repairs that you plan will really improve the condition of the structure. For example, if you are replacing pile caps with deeper ones to increase the bridge capacity, you must ensure that the piles are in good condition to support the heavier loadings. If you don't, you may be very disappointed in the results of your upgrade project.

An inspection should cover the entire timber trestles from the ties down to below the ground lines. All members should be inspected and their condition recorded. The internal soundness of wood should be checked. Timber does not advertise its condition the way steel or even concrete does. Timber can be badly deteriorated before there is any external indication. An experienced inspector can identify areas of concern fairly reliably by sounding the timber with a hammer. All suspect areas should be checked and bored to determine the extent of the interior decay. The limits of deterioration should be checked and recorded on the inspection report. Special attention should be paid to areas typically susceptible to decay, such as joints and connections, ground line contact and at the water line. You will find that sketches and photos will prove invaluable when you start planning the repair project back at the office.

I strongly recommend the engineer who will be responsible for the repair projects be on-site during the inspection. No matter how good the inspection, or how conscientious the inspectors are in preparing a report, there are items which won't be put down in writing.

A full inspection will tell you the current condition of the structure. From this you can determine if repairs or upgrades are necessary in order to handle the desired traffic, and it will give you a basis for determining the most economical method of repair.

The vast majority of the railroads I contacted are extending the life of their timber bridges by replacing, in kind, members as they wear out.

Most commonly this involves the replacement of ties, stringers, and pile caps, the posting of piles when they have deteriorated and the replacing of an entire bent with a new framed bent when required.

One of the great advantages of timber is its ease to work with. In most cases the actual replacement of deteriorated members is a simple procedure. The challenge is usually in completing the repair while keeping the transportation department operating and happy. Some of you may not agree, but with prior planning and good communications you can even keep transportation happy, or at least reasonably satisfied.

If the repair work is contracted out, be sure the contractor understands the constraints of traffic, and how long a work window he will have. With a contractor you haven't worked with before, it can be a good idea to find out what work he has planned during a window, and determine if it can be reasonably accomplished and everything put together in that time.

As I mentioned, most timber repairs can be accomplished relatively easily, but you often have to disconnect and remove a number of members just to get at the ones which need to be replaced. In some cases you can cut the fasteners and replace stringers from the sides, or pile caps from below. Often, however, it is necessary to gain access from above. This can require the removal of rails, guard rails, spacer timbers and ties in order to get to the stringers. Pile caps can be a similar problem to get out.

Posting piles is also a common repair. The deteriorated section of the pile is cut out and replaced. If several piles or two adjacent piles in a single bent require posting, the entire bent should be cut off, a sill timber installed and the entire bent framed. Some guidance on recommended practices for repairs is contained at the end of Chapter 7, Part 3, of the AREA manual.

Some railroads are upgrading the capacities of timber bridges with a number of interesting methods. Typically, projects to upgrade timber bridges are confined to select routes: where timber bridges are still on main lines, on high volume branches or lines handling unit trains. The extent of the work required depends on the current condition of the structure and the intended traffic.

Increasing the capacity of a bridge, in some cases, can be accomplished by something as simple as replacing the pile caps with deeper

caps. This improves the distribution of load to all of the piles in the bent. A similar improvement can be accomplished by installing double caps.

The approaches to ballasted deck bridges can be easier to maintain than open deck bridges like this one. Ballasted decks can also provide a better dissipation of impact loadings. In some cases by replacing an open deck with a ballasted deck bridge your bridge may be able to provide better service and be less susceptible to certain types of mechanical damage. In cases where major portions of an existing open deck bridges require replacement anyway, this can often be the best way to go.

An interesting system, currently being looked at for installing a ballast deck on an existing structure, is to use a post tensioned laminated deck. This system has been used on a number of highway bridges. The deck is made up of many two-inch thick boards laminated together and bolted. The depth of the boards used will vary depending upon loading and span length. The deck sections are brought to the site pre-assembled and put in place directly on the pile caps. Because it is made up of many small pieces that are pressure treated prior to assembly, the deck will have close to complete penetration from the preservative. The many small boards bolted together will not have the problem of checking that larger timbers do.

Where the existing timber bridge is in poor condition, railroads are utilizing portions of the existing structure and building a new structure on top of them to save money. Concrete pile caps placed on top of existing timber piles is one way of doing this. The pile caps are pre-cast with spaced holes through them for the installation of drift pins. Stringers can be of whatever material is most economical. Typically steel stringers are used, but timber or even concrete could be used.

Another replacement method, perhaps more suited to low timber trestles, is to install culvert pipes under them and then place fill over the existing structure. Whenever you change the opening size through a structure make sure the new opening will provide sufficient flow capacity.

A number of railroads have been using some form of in-place treating to extend the service life of their bridges. As an outgrowth of work in the in-place treatment of utility poles, in-

place treating of timber railroad bridges started in the early 1950s. It took the rail industry a while to accept this new procedure, but over the years it has had a very good performance record. It has shown an ability to effectively stop decay, typically, for 10 to 15 years. The products used have changed over the years as a result of continued research and in response to, or in anticipation of, changes in environmental regulations. The in-place treatment products and methods vary depending on the application requirements and the location. Often several products are used on the same structure to complement each other, each having its own advantages and disadvantages.

Copper naphenate and oil are used in liquid form and applied under pressure into the member to be treated. The oil is used primarily as a carrier for the copper naphenate. This method may not be environmentally acceptable where the timber is in contact with streams, rivers or other bodies of water.

Chloro picrin in vials can be implanted in the timber. The caps on the vials degrade, releasing the chloro picrin as a gas. The gas acts as a fumigant, traveling through the pores of the wood to provide protection throughout the member.

For surface applications there is a paste that is made of a mix of creosote and sodium fluoride. The sodium fluoride is drawn into the wood by water and, thus, carried to the damp portions of the timber where it is most susceptible to decay. This is marketed under several names depending upon the relative mix of creosote and sodium fluoride. This product is good for treating the ground line area of piles and makes an excellent treatment for cut ends of timbers and bored holes. The creosote provides surface protection and the sodium fluoride drawn into the wood provides internal protection.

Sodium fluoride can also be used in solid forms; as rods inserted into drilled holes in the wood, or as pads under tie plates or other locations. The sodium fluoride will dissolve in water and the protection will be carried to the moist locations in the wood.

After treating with any of these methods that required boring into the timber members, all holes are sealed with treated wood plugs.

There is a relatively new system for the on-site treatment of timber. This is similar to that

used for on-site treating of railroad ties. This system consists of placing rods of fused borate into pre-drilled holes in the timber. Each rod is approximately three inches long and three-fourths inch in diameter. The number and locations of holes required vary depending on the size and type of member. More rods are placed near locations that are typically prone to deterioration. Plastic caps are used to seal the hole after the rods are installed.

This system has several interesting features. Most of the work can easily be done by railroad personnel and the only special equipment required to work with the borate is a pair of gloves to avoid skin contact.

The borate dissolves in water creating boric acid, which travels with the moisture in the wood to provide protection at the areas which most require it. This system should provide protection to the timber for about five years. Retreating is relatively easy. When the borate has completely dissolved, all you have to do is pull off the caps on the holes, put new borate rods in, and put the caps back on. This product is being tested on several railroad bridges. I also understand that the Association of American Railroads is currently doing some valuations of the use of borate in similar applications. I would recommend caution if you are considering using this for an entire structure. Be careful to ensure the placement of the holes for the borate rods does not decrease the strength of structural members.

In-place treating has provided years of extended life to many timber trestles throughout North America. It can be a very good, cost effective procedure of protecting an existing structure, but there are a number of situations where it is not appropriate or worth the cost. Each bridge must be looked at individually. It is important to look at the existing condition of the bridge, its current age, as well as the long range plans for the section of railroad it is on, before making the decision.

In-place treating does not improve the condition of a timber structure. It only prevents further deterioration from decay and protection from many insects. Essentially, it preserves the structure in its present condition until the treatment concentration dissipates. If mechanical damage is causing your deterioration you have to solve this problem first before treating will help. Causes of mechanical wear and deteriora-

tion should be investigated and repaired prior to considering in-place treatment.

Areas of ground line contact and at the water line are especially susceptible to decay and warrant special attention. There are a number of products on the market for treating and preserving these areas.

For coastal areas, where marine borers are a problem, there is a system for wrapping piles. The pile wrap cuts off oxygen to the pile effectively protecting against borers.

Another product that warrants your consideration is tropical hardwoods. These woods are very dense, strong and have a natural resistance to decay. Environmental regulations already prohibit or restrict the use of creosote treated timbers in certain areas. This is becoming more common where timbers come into contact with water. It is likely that these restrictions are only going to become stricter. There is also the potential liability involved for existing structures if regulations in the location change. In some of these cases the use of naturally decay-resistant timber may offer a good solution.

Some of the most important things you can do to extend the life of your structures are also the simplest and often cheapest. Something as easy as keeping the base of the structure free of debris will save it from significant damage and extend its life. Perhaps most important is simply ensuring that repairs and improvements are done correctly. If the cut ends of timbers or bored holes aren't properly treated you will get only a small fraction of the life expectancy from your repairs. Another thing to look at is the quality of timber you are ordering. In the long run the least expensive repair may not be the one using the cheapest treated lumber you can find. If timber isn't carefully treated and properly dried you may find you have spent a lot of money for something that will require replacement again long before it should. In-place treatment methods have come a long way, but they can't make up for improper installation.

There is no one solution that best fits every situation. Each bridge has to be evaluated individually. The proper decision means more than considering the cheapest repair. The long range plans for the line on which the bridge is on may have overriding factors. If the line is expected to have a large increase in traffic in the future or is planned to handle heavy unit trains, actu-

ally replacing the bridge may be the best solution. On the other hand, if the future of the line is uncertain, perhaps just repairing it enough to keep it safe for a couple more years may be all that is warranted. In these times of scarce resources, spend your time and money in the areas where it will be the most beneficial.

I found that what railroads aren't doing to preserve their timber bridges was almost as interesting as what they are doing. None of the railroads I contacted indicated they used any form of fire protection on their timber bridges. The systems that I am aware of are only effective for about five years, and getting proper and effective retreating is difficult. Although it is being used in a few special situations, in most cases it seems the benefits of treating are not worth the cost.

Another item that surprised me was that although many railroads expressed concern about the cost and availability of high quality stringers and pile caps, no one seems to be using glue laminated timbers. My understanding is that glue laminated timbers are still more expensive, and that there can be problems with the glue joints and the treatment.

Quality timbers are getting harder to find, and there are serious environmental and safety concerns about creosote and other preservatives. Even the disposal of old treated timber is becoming a problem. Despite these, if used responsibly, there are still many situations where timber can be an economical repair solution. With current preservatives and in-place treating, timber trestles have shown that they can survive the test of time. For many years timber bridges have served the rail industry well. Perhaps our desire to replace them with something "permanent" is sometimes more a matter of not truly feeling comfortable with timber rather than pure economics. There are still far too many timber bridges out there to replace right away. Even if we wanted to and could find the money, it would take many years

to replace them all. So, ladies and gentlemen, whether we like it or not, we are stuck with them and need to find ways to prolong their lives. We don't have to look at this as a problem. Timber can be a very economical material. With proper inspection, maintenance and treating, timber trestles can continue to serve the rail industry for many years. Thank you. (Applause)

Mr. Saletnik: Thank you very much, Ron. Our next presentation is on pile driving technology. On the program it shows it was to be given by Mr. Michael Holloway from Insitutech in Oakland, California. Mr. Holloway is unable to attend and we have in his place Dr. Allen Davis. However, Mr. Holloway's report will be included in the Proceedings.

Dr. Davis has a Doctor of Science Degree, a Ph.D. and a Master of Science in Civil Engineering. For ten years Dr. Davis was a professor in geotechnics and foundation engineering at the University of Birmingham, England. He also spent time with several other companies there and in France. In 1988 Dr. Davis became director of U.S.A. operations, Essi-Testconsult in Asheville, North Carolina. He is now an associate for STS Consultants in Northbrook, Illinois. Dr. Davis has been involved in the development of N.D.T. methods for pile and drilled shaft inspectors, the design and control of deep foundations in many parts of the world, including United Kingdom, France, Philippines, Egypt and Algeria. He has been involved in control testing of piles using N.D.T., and also large strain dynamic methods using the wave equation in Europe, Hong Kong and the United States. Dr. Davis has published over 50 articles, 19 of which are on piling. He is a member of Subcommittee on Deep Foundations for the Transportation Research Board. Please join me in welcoming Dr. Davis.

PILE DRIVING TECHNOLOGY

Dr. Allen G. Davis

STS Consultants

Thank you very much. I might say that even though some of us in the audience and even myself are getting on in years, piling has been with us for the last 140 years or so. I think it is interesting to note how piling has developed. When I was a student at the university, piling to me seemed to be folklore or art.

One of the biggest lessons I learned as a young engineer was in the Philippines. When I got out there to design the foundations and control the foundations for a cement plant I said, "Well, we should go really for these heavy loads. We should be looking at drill shafts." Drill shafts would be taking something like 500, 600 tons per shaft. I said, "We'll really get economy here. What about contractors here who can give us drill shafts?" They said, "Well, we know one in Hong Kong. He builds about three or four drill shafts a day." And I worked that out to about two to three years to complete the plant. It's this sort of problem with piling that people meet which really brings it down from a nice 100 percent science to an art.

You go, for instance, to Chicago. Chicago people are very interested in drill shafts, caissons. They have a lot of experience in it. But you go somewhere into North Carolina, where I also have experience, and you try to get a drill shaft contractor to work in the Appalachians and you won't find one. They are familiar with driven piling. In certain parts of the world they like using auger piling, in other parts of the world they like using tubes. I think even today the so-called piling industry is very fragmented.

My experience over the last 30 years has been that people have had bright ideas and new techniques, new technologies. They have introduced them into the industry. What happens? That technique takes off for about ten years and then the company that has the proprietary type of technique folds. All of a sudden you try to get that type of pile and you can't, because it doesn't exist any more.

That's been my experience over 30 years. I get familiar with a pile type and I want to use it on the next job and I can't use it. I have to go back to something else. I think that's one of the problems with piling and when you look at

textbooks, I'm sure some of you are familiar with the old books written in the late forties or earlier fifties which was Chellis which was the bible of pile types where he described the different types of pile that could be constructed and the different types of hammers which were available. The energies those hammers could give. Now when I read Chellis, in fact I have some diagrams here from Chellis, I think that's only 30 years ago and the industry has changed mainly because the companies who were constructing piles in those days probably went bankrupt and the proprietary type of pile they were using has changed. We tend now to standardize pile types. We talk about driven piles, concrete, precast, prestressed, steel piles, steel tube piles, open piles parted with concrete or steel H piles and you can go on. I could fill probably about an hour just talking about the different possible types but I find that a pretty boring subject because all that you do is catalog the different types and it doesn't really mean that you get any experience of those types. Those of you working over in California might never need some of the types that I have talked about which are only available on the east coast. So it's very difficult to know how to address the subject of different pile types. I think what I would like to do is just go through basically what people were building 50 to 80 years ago and go on from that and find how we have rationalized our approach to measuring their capacity to do the job they were intended for. I think we are now getting some modern developments which will help us to overcome the uncertainty in piling, which is still there because of the nature of the piling industry. Technically we are now getting tools which we can incorporate into piling contracts to help us to determine the right pile for the job, the right pile hammer to give the right energy and to determine the ultimate bearing capacity or the working load that pile can take in the given circumstance.

I still think there are many variables that we don't master as piling engineers, but I think we are getting that slowly by being able to monitor what's going on during the piling exercise.

I'll start off with some overheads and run

through some different types.

This is a fairly common type of driven pile which has been with us for many years in one form or another. The old open-ended tube which is driven down to some seating, preferably some good identifiable stratum where we know we are going to drive into an acceptable set. I take it most of you have a notion of what the set is. The set is the number of blows per inch that a pile can be driven on. Now that set has been the criteria for acceptability or not for driven piles since 1860 or 1870 when engineers were talking about pile set on driven piles. In fact it did coincide pretty much with the arrival of more efficient hammers and steel in the construction industry. Before we had steel or concrete, obviously piles were timber. Most piles were spliced timber. You got good runs of 60 foot pines sometimes or 60 foot oak which gave you a good length shaft. Many of the early jobs required very light loads on those piles. We're looking at working loads of between 10 and 50 tons quite commonly up to the turn of the century. So the actual driving action originally used to be a simple drop weight hammer operated by a steam engine. You even had horses pulling a winch to make it operate or human beings operating the winch. Then you went to the simple steam engine to operate the winch, but it was sort of a free fall drop hammer and it wasn't until the 1880s or 1890s that you got the machinery actually incorporated in the hammer itself.

So we were looking at loads of 10 to 50 tons to drive that pile to a set. It didn't mean that you had much capacity on that shaft so a simple driving action would do it. It's was very simple pile to construct. You drove it into a set, excavated out the soil which was in the tube, filled it with concrete or left it hollow in some cases, and that pile was sufficient to take the relatively light loads that you passed over it. The same for timber.

Actually the arrival of concrete pushed the technology a little bit further. First of all, precast, simple precast square section of piles which were reinforced with concrete. It's interesting to note that the reinforcement was to cope essentially with handling stresses. Pile had to be moved from place to place. From the casting yard it had to be transported to the site. It had to be lifted up by the crane and it was in that lifting motion that you got the worst stresses

on the pile. The pile actually had a tremendous amount of bending stress on it. Most of the reinforcement in it was to cope with this problem of bending as it was lifted into position before driving. Driving forces were not very high. Most piles suffered. Simple precast piles suffered when they were lifted into place before driving. But as hammers became more and more efficient and bigger loads were asked of piles, it was noticed that bursting stresses during driving were creating a large amount of problems on simple precast piles.

So the technique which was developing in the twenties and thirties was prestressing. Prestressed piles were incorporated and you had a tremendous number of varieties of prestressed pilings and types: square section, hexagonal, octagonal. The main problem with these piles was jointing. Jointing the piles themselves. Jointing became an art. Splicing and jointing. Several proprietary types of joints were developed such as bayonet splices. We just joined the two shafts together as they were driving. There was very little manhours put into the action of joining. But you still come back to the most favorite type of joint on a concrete pile which is the welded joint where you have a welded tube about the joint itself.

The hammers were developing very fast at the same time. For large loads they came up with the idea that what we should do is to lighten the section of the pile shaft. We could go to a quite large diameter shaft, as high as three to four feet in diameter, with prestressed piles. Some of them are five and six feet in diameter. But in order to reduce the amount of weight in that size of driven shaft, you must reduce the amount of concrete. So the cylindrically spun concrete prestressed pile came into being. Many of you are familiar with the Raymond Company. They were one of the forerunners of this type of pile. But the major problem with the spun concrete prestressed pile was it had to be built in a very special casting yard and, as a result, transport costs were very high. It was fine for marine environments where you could build your yard on the coast and transport these large piles down by barge and ship them down the coast, but cross country they were quite inhibiting. They were restrictive in that practice and you do not see many of these spun concrete piles inland because of transport costs.

Those are pretty much the three types of con-

crete piles that you see today. People used to have dreams at night and they used to think, "Well, we should get over certain problems. Wouldn't it be nice if we had a 60 foot timber pile. If you had a 60 foot timber pile what we could do is if we have a deep bearing stratum, we could make composite pile." People used to dream up all sorts of composite piles where they would drive a 60 foot section of timber and then on top of that drive a steel tube, pour concrete down that steel tube, extract the steel tube and then be left with a composite of concrete and timber pile. This was fine until it was pointed out that one of the major problems here was lateral loads, bending moments on piles of this type. They are really only suitable in situations where you have a straight axle load coming down the pile shaft itself.

This type of composite pile was all the rage and many companies founded their reputation on it in the 1940s and 1950s but I don't think you'll find many today existing with that type of shaft.

Another favorite one of the 1960s was the Raymond step-table pile or many of the variations of these step-table piles. These were considered to be a cheap way of going about things. It was proven by some university research that a tapered carrot-shaped pile shaft gave you a better bearing capacity than a straight-sided cylindrical pile. So the idea was to get some cheap type of corrugated thin walled tube, metal tube, steel tube, which would be driven in using a mandrel. A mandrel is a bottom-driving hammer down the pile section itself. It would start off at a six inch diameter, go up to nine inch, 12 inch, 18 inch and you could end up with whatever pile shape you liked. But the effect was to effectively have a carrot-shape pile of very cheap construction. The thinner, rather the smaller diameter end section had less resistance to penetration and this was a relatively cheap pile. But again these disappeared because one of the major problems with these is that the extra loads demanded today are not satisfied with this type of construction. You cannot get the driving stress into shells of this nature. You just tear the shells apart.

Another example of this, of course, is one pile which has virtually disappeared. This is a composite I am showing here, but in fact they used to construct piles of this nature. We used

to call them cast-in-place. These were driven cast-in-place piles where you had a metal tube driven in with a bottom shoe. The shoe was lost once the tube was in place and then a concrete plug was expanded into the ground using the mandrel down the hole so that you got a bulb expanded the depth you wanted to transfer your load to. You could either then put in a precast concrete element when you withdrew the tube or you could pour fresh concrete in and have a cast-in-place type construction. But again, these shafts had major problems and whether you go to this cast-in-place or driven-in-place technique, the major problems are the integrity of the concrete which is cast into the shafts. You cannot rely on it and there have been well-documented histories that this type of pile is not necessarily satisfactory, particularly near the head of the shaft where you have soft soils, things like peat, flowing sands, problems like that where you get necking in the top.

So again, with the increased stresses demanded now on piles this type of pile has virtually disappeared.

Just briefly, before I go on. Pile hammers. We hear a lot these days about the very high efficiency hammers which are used and I'll go through a comparative table shortly to show you how things have developed. Nowadays we are finding five major types of hammers. The hammers are referred to as air/steam hammers which is this one. It's a simple technique which hasn't evolved very much over the last 100 years. It's evolved in its efficiency. This hammer has improved. The actual energy output that we can get from it is enormous and if you look to the off-shore industry, most of the hammers which are driving piles off-shore, tubular piles, are of the air/steam variety, the vulcan type where you have huge energy inputs. You're talking about very, very large tube piles in the order of ten foot diameter being driven. These steam hammers can give tremendous energy.

The tube on the right is commonly known as open ended or closed end diesel hammers. Some people refer to them as single acting or double acting hammers. Single acting was the original type where the diesel action set off the compression in the compression chamber, lifted the ram and allowed the ram to fall back on to the pile. The double acting or closed end had a bounce chamber which allowed double com-

pression, so effectively, you have a double acting compression and you get an extra input, you impact effectively the combustible material in the bounce chamber. This gives you an extra energy drive. These double acting hammers actually have a double blow on the pile itself.

Another type of pile hammer which was heralded in the 1960s as the savior, as the solution for all problems, was the vibratory hammer. Everybody thought this would solve everything, the environmental problem of noise and that we would get tremendous efficiency from the vibrator where we could put in a very simple system of a mass and a spring and get that vibrating and putting the pile in residence with the ground. Once we hit the right resident frequency we would quadruple or quintuple the energy input into driving so that we would get tremendous efficiency and for very little money, if you like, very little input, we would get very fast drive.

Unfortunately this was shown to be ideal for certain types of soils, notably water-bearing sands where we can really get the thing in motion, in residence, but when it comes to mixed soil profiles like clays and sand mixes, silting clays, the vibrating hammer is not so ideal. You don't find many driven piling sites nowadays with a vibrating hammer. You find it used pretty much on sheet piling jobs where it's a very efficient type. The beauty of it is it can be used for driving and for extracting, it has a very great ability for extraction, much more than any type of pile hammer.

Another type of pile hammer which is the coming thing, but is very expensive, is the hydraulic hammer. Some hydraulic hammers get up to 100 tons in equivalent gram weight and these are real fantastic beasts. The beauty of them is that they give very little noise and then can be instrumented with modern instruments so you can actually work out what's happening during the pile driving to the pile itself, in terms of its bearing capacity and in terms of the ultimate resistance you can get.

So pile hammers have evolved drastically in the last 10 to 15 years. They have really gone up in efficiency and I reckon they have jumped ahead of the piling industry. We can now pick any selection of pile hammer we like to give us huge energy input. But is it necessarily what we really want because you can over drive a pile. This is a table of selected impact pile hammers

from the 1960s which is not that long ago. These are typical piles and the important column is striking parts. The biggest one there is the Vulcan 16 at the bottom which has a weight of 16,000 pounds, eight tons. That was fairly common. It was very unusual to go above eight tons 20 or 30 years ago in terms of pile hammer. If you look at page 11, table 2, in the little booklet that I put out there, the DFI, the Deep Foundation Institution manual, there's a table in there that gives some typical examples of piling hammers and their efficiencies now. We're looking at 40 or 50 tons quite commonly and energy inputs which are ten times what was being practiced in the fifties and sixties. It's great to have that energy. It's great to have that weight and it certainly does damage the pile less. The bigger the hammer the smaller the drop weight you need and if you want to achieve a certain set, it's a lovely rule of thumb actually, go for the biggest hammer you can because like that the tensile stresses in the pile on driving are reduced to a minimum.

One of the biggest problems in pile driving is the tensile stress of the pile on driving and immediately after driving. That's one of the major factors of pile breaking. Nowadays we can actually measure the tensile stress that is going down a pile shaft during driving. That information allows us to tell whether we have the right hammer for the job, whether we are running the risk of damaging piles and if it is a good, quality control tool.

The interesting feature also is the development of different hammer cushions. In my young days, we put several layers of plywood between the hammer head itself and the pile. The most common type of hammer cushion was a plywood cushion. The helmet, if you like, sat on top of the head and the cushion was varied depending on how much effort we wanted to put in it.

This is a graph of the actual peak force in the pile shaft as a function of the parameter which becomes more and more important these days. I'm sorry to introduce this type of parameter but it characterizes a pile. It's known as piling impedance. The impedance of a pile is really the material and the geometrical quality of that particular pile. It's in fact, the equation for it is ρCA . Now ρCA , ρ is a function of the density of the material; C is a function of how fast the shock wave goes down the pile when

you drive it, and A is the cross section area of the pile. So you can see the bigger the pile for a given material, the bigger the impedance. The bigger the diameter or the cross section area of the pile, the bigger the impedance. It's interesting here what we're looking at. If we take the Vulcan 10 which is one type of hammer, this plot is showing that as the pile size increases for a given pile material the impedance increases, but if you use a certain type of cushion the peak force in the pile increases. That's the beauty of it. For a given impedance we get a much greater peak force into that shaft if we use an aluminum micarta cushion which is a proprietary type of cushion as opposed to the old plywood. We got so much energy loss through the plywood. What we are effectively getting over time was we were putting just as much force in with a given hammer but that force was spread out over a longer time span. So if you took the micarta type aluminum cushion you got a very short peak of time which gave you a much greater force input and, hence, a much greater driving power. But if we did that at the same time we increased the tensile stresses in the pile itself so that is something we have to be aware of. A lot of people, by introducing new hammer cushions like this, created the problem of breaking the pile while they were driving it because instead of using this relatively soft plywood type cushion and spreading out the load over time, they were hitting it with a very sharp blow. The pile itself was suffering because of the high tensile. They were very short spanned tensile forces, but very high indeed. A major problem occurred in the sixties particularly where a lot of piles started to be broken up, mostly concrete, by this type of action.

Have you thought how the old boys in 1890 would determine what sort of bearing capacity they would get out of their pile? Well, they didn't really. All they said was it was timber. What we need to do is work out roughly what timber can take in compression. We know timber is pretty good in bending. It has the grain which works in a certain way, so that most of the bending that we're going to get can be taken anyway by the timber. We know that timber, if used as a column, will give us so much in a given section, 15 tons, 20 tons, safely. If we drive with the drop hammer that we have, we drive it to a set, something like it takes 50

blows per inch. We know from rule-of-thumb experience that timber pile would give us so much bearing capacity. That was it. That's what they did. Then people got the idea that there must be some science to that. There must be some logic. Potential energy, kinetic energy. If you put so much energy in, that means to say that the soil is going to take that energy and therefore you can work out some simple equation.

They are all based on the very simple equation here of W , the weight of the hammer times H , it's drop, the height of drop of that hammer, is equal to the soil resistance times the deflection or the set of that pile as it's driven. In other words, the greater the set, the pile penetration per blow, you will effectively get a lower soil resistance. They are inversely proportional. So, the smaller the set, the greater the soil resistance. In other words, you could bang it a lot to get it to penetrate one inch. In fact, I'm sure a lot of people use the Engineering Use Formula where that is nothing more or less than the equation at the top of use of potential energy equals energy stored in the soil. That's effectively what the Engineering Use Formula is. A factor of safety of six applies to that formula, so you can see how much we trust it to give us the actual soil resistance.

It's interesting that even with the safety factor of six, how far out that formula can be. People used to ask how to measure set. I remember being a young engineer on-site. I had my textbooks and in there it showed a diagram like this where you have a piece of graph paper stuck on a straight edge which was held on a reference beam and you had a pencil tied to the pile itself. As the pile was driven the pencil would go up and down and you would have a mark of the temporary set, that is the elastic compression of the pile shaft, and the permanent set which would come out on that little graph up here. You could work it out. You ought to try that when it's raining and there's mud around. (Laughter) It's the greatest experience you've ever had as a piling engineer. Really we should be looking for something more scientific for measuring set than this simple little pencil and a piece of graph paper.

It's here that I think tremendous progress started to be made at the end of the sixties and the beginning of the seventies when the application of what was known as the "wave equa-

tion" came into use. The wave equation was developed by a man called Smith in the 1960s when computers started to come in. I'm sorry to mention that dirty word, computer, because it rules our lives these days. It's essential when you apply the wave equation system that a computer be used. When I was doing my master's in the early sixties as a geotechnical engineer, the word model, numerical model, mathematical model was a dirty word. What it did was it took very simplifying assumptions on how the soil behaved, or how the pile behaved. Models of any sort were so simplifying and you said, "No, that doesn't really fit what happens in nature". But more and more as computers have become competent, as we have become more and more masters of material properties in structures, in elements, beams, columns, piles, we have a feel for these models and these models can now be used with a lot more confidence. I think that it is over the last ten years that we have really seen the application of modeling coming into civil engineering. Particularly in dirty things like ground engineering where soil is soil and you can't really model soil but we are getting there I think very slowly. The model that the wave equation uses is very simple. All that it is it says if you hit a pile on top of the head and you want to measure what happens as you hit it you have to say that that shock wave is going down the pile to the toe and then it's coming back up again. It's reflected off the toe. So the model we have to get has to model the passage in time of this wave as it goes down through the pile.

So the way it is done is the pile and pile driving unit is separated into little elements and those elements are made up of a mass. It has it's own weight, it's own impedance dynamically and it's also a spring. If you think about it, a concrete shaft has a certain compressibility. It has a spring constant. That energy goes down the shaft, it's transmitted from element to element, but at the same time some of that energy goes out through the side of the shaft into the soil. We have to model in some way what happens to that energy as it goes into the soil. Initially, if it's a very low energy impact, that energy goes out as a radiated dampening. The soil acts as a damper around the pile itself so all that we need is some sort of linear damper which tells us how much energy is dissipated out through the side. Eventually if the energy

gets high enough you get failure between the pile shaft and the soil and the soil actually slides up the pile shaft sides so we have a sliding frictional effect. We can actually model that as a simple slider, in other words, as an ultimate friction beyond which we can go. The simple wave equation model is the massing spring for the pile itself and the damper slider on the soil. It's very easy to do, theoretically, but it's when you have to put values into those parameters that you come into problems. It wasn't until equipment could catch up with this modeling to measure what was happening on-site that we really got confidence in what was going on in the wave equation.

Nowadays we do have equipment, and I'll show you some of it on the slides at the end, where we can actually measure several things. I've shown here the compression stress in a pile. We can actually measure the compression stress. We can measure the tensile stress which is a very important one, if you remember, because that's the one which controls whether the pile will break up or not during driving. We can measure the capacity if you use the model correctly. We can work out what the soil resistance is on the sliders down the side of the shaft, and what the toe of the shaft can tell us. So we can work out the capacity and we can work out against that. We can calibrate the stroke of the ram so that we know for a given stroke we should get a given capacity and a given penetration resistance in a given soil. That's basically a way of using these models to arrive at working out the driveability or the suitability of a given system for driving piles into a given soil formation using the available hammers you have on the job and using the available pile types you can get. It does pay on large projects to actually run these pre-project programs where you work out which is the best hammer for the job. In fact, piling contractors often do this just to work out for themselves which is the best hammer to bring onto the job. So that's one use of the wave equation.

An interesting one here which you will find in the DFI manual is the comparison between the ultimate power capacity worked out using the wave equation and the Engineering News Record. Remember that pile driving formula. Now this is a case for different concrete piles we have here, pipe pile at the bottom and 12 inch and 16 inch concrete pile. The equivalent

for a 16 inch concrete pile with the same hammer from the Engineering News Record gives us the capacity in this particular type of soil which is as much as three to four times that predicted from the wave equation. And it can be the other way around. So which is correct? Which is true? That is the question we have to ask ourselves.

The wave equation itself has been tested now. This is a plot I put up with tongue-in-cheek because the wave equation was developed by one particular group of people working out of one university who formed one commercial company to market this idea in the industry. They sold the technology which they knew they were the only people who could do it. The engineers who took on board this technology initially had to believe that what those university people were telling them was correct and true. To back up their work they put up a whole stack of results which showed what's known as the CAPWAP which is the pile driving analyzer predictability using dynamic methods against static load tests. You might or might not be familiar with static load tests. But you could do a static load test on a pile to test its ultimate capacity that means you have to produce a larger amount of reaction load either using a form of cantilever or in the form of reaction beams reacting on other piles and that costs a lot of money. If you are looking to do a pile test for ultimate you're looking at something like \$15,000 to \$20,000 per test to take a pile to ultimate. On the big ones it can be in excess of \$150,000 so the idea of the dynamic method was if you could predict the bearing capacity, using these techniques, to get over that extra cost and you would have confidence in your pile compilation.

So this is pretty much the way they went about it. They did static loads tests after they did driving tests and they showed they had a one-for-one plot.

Now that one-for-one plot, I refer you to the DFI manual, because in fact it's not as good as that. You have to make sure that you are talking about comparisons between piles which have really been taken to failure both dynamically and statically. On this plot there are some. The only ones which are really valid are the failing static load tests and a fully mobilized dynamic test. A lot of dynamic tests are not fully mobilized. The only good correlation here are those which are marked FF on that plot. You'll see they are pretty much near the line but if you

don't do the test properly you can see that the scatter there is not acceptable. You cannot say there is a good correlation between the static load and the dynamic test. It's essential that if you do this exercise you are taking both tests to failure, the dynamic and the static. And that's a warning that I think is well underlined in the DFI handbook.

Just a brief turn to more high tech if you like. The use now of a very simple system known as the radar gun to measure pile hammer efficiencies. The radar gun is very simple. It's just like a simple radar gun for catching speeders on interstates which focuses onto a moving mass. Now radar relies on, in this case, a mass that moves. It must have velocity. It can't tell you anything about something which is sitting still. So what it does is it focuses onto the pile hammer itself to the ram. The ram moves and you can measure the velocity of that ram with time and that's all the radar gun does. It picks up the velocity of the hammer.

The typical recording trace is a detailed trace in the one above where we have the hammer blow separated into the impact or downwards motion which is the steep one here running up here. As the load falls off we get the upstroke cycle here. The slope of that down cycle is proportional to gravity. It measures effectively the G forces which are generated and the actual impact velocity against time should not exceed the slope of gravity. That's effectively it. You can actually look at the efficiency of your hammer and the sort of typical trace over time. That's a more typical trace, the one below, and that's after several hammer blows. The information you can get out of it can be used for looking at how efficient your hammer is and you can actually adjust your hammer to take account of this. The top chart here shows a hammer which is working at very poor efficiency and you can see that the downstroke is a departure from gravity line and that the amount of departure of that downstroke from gravity is a measure of friction losses in the hammer itself. So the piling contractor can come on site and use this radar gun and he can work out how much friction loss or how much efficiency he is getting out of his hammer and he can adjust that to end up with a more suitable trace. That really is an application, I think, of very efficient mobile technology to measure driving stresses.

Time is getting short and I would like to just run briefly through a few slides.

(Whereupon there was a slide presentation)

Following is report of Mr. D. Michael Holloway, InSituTech, Oakland, California, and Patrick J. Hannigan, STS Consultants, Northbrook, Illinois.

DYNAMIC METHODS FOR ENGINEERING PILE FOUNDATIONS

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Introduction

The use and abuse of dynamic methods in piling practice remains an art form in some segments of the industry. The "geo-mystical" nature of foundation engineering is often cited as the cause of design and construction problems with pile foundations, sometimes with considerable accuracy. The builder encounters "unforeseen conditions", and the designer argues that there are deficiencies in the builder's equipment and/or materials. Often, the project comes to a screeching halt.

The research of the past three decades has substantially improved our understanding of the behavior of impact-driven piles. More importantly, innovative applications of the evolving technology have led to practical solutions for pile design/construction problems.

An overview of dynamic methods used in piling practice follows. Case histories are used to illustrate applications of the available tools. Recommendations are offered for integrating these techniques into pile design and construction for railroad facilities, as the American Railway Bridge and Building Association enters its next century.

Background

Impact pile driving is a crude process for installing foundations to support a wide variety of structures. For centuries, men have driven increasingly larger sticks into the ground by dropping larger rams onto the piles from greater heights. Beneath important structures, the rule of thumb was to drive as many piles as possible and, whenever possible, drive them to refusal.

Well into the 20th century, the most common pile foundation involved the installation of suitable lengths of timber piles with a single-acting air/steam hammer, such as a Vulcan 1 (15,000 feet per pound). Pilot hole jetting or predrilling techniques facilitated penetration through troublesome overburden materials to the desired end bearing strata.

Energy Formulae

Basic laws of physics were used to idealize pile driving as point mass impact of ram and pile. The maximum kinetic energy at impact is

equated to the work done in overcoming the resisting forces in the soil in order to achieve permanent penetration (set). The most familiar version of the so-called energy formulae is the Engineering News formula. Hundreds of energy formulae have been published in the engineering literature in the past century. Most show improved correlations with static load test results in comparison with previous energy formulae. It is useful to note that most of the formulae were devised from tests involving timber piles driven with small air/steam hammers.

The demand for higher capacity piles spawned dramatic changes in foundation engineering practice in recent decades. Steel and concrete piles of increasing cross section and length required much larger pile driving equipment to achieve prescribed penetrations. Near-shore and offshore foundations requirements have driven the industry to develop pile driving equipment delivering in excess of a million feet per pound to the pile head. Still larger driving systems are coming on line at this time.

One-Dimensional Wave Equation

Recognition of the gross simplifications of energy formulae in modeling impact pile driving behavior, led to development of the one-dimensional wave equation model of the problem. E.A.L. Smith developed the algorithms for a discrete element model of the pile driving system (Smith, 1955). It is commonly understood that several key parameters (for example pile stiffness and hammer/pile cushion properties) may play an important role in the pile driving process. Parola (1970) drew a revealing comparison between popular energy formulae and the wave equation analysis, as shown in Table 1. All the methods obviously consider hammer energy in their formulation; however, note that several energy formulae account for pile stiffness (impedance) incorrectly.

With the advent of digital computers, Smith had the means to solve practical problems. Wave equation analysis of pile driving is one of the first civil engineering applications of digital details of the numerical model along with recommendations for its use based on his correlations of axial capacity predictions with static load test results. A schematic diagram of Smith's discrete element model is given in Figure 1.

Basic improvements in Smith's model, there-

after, have enhanced our ability to model more complex hammer behavior (such as single- and double-acting diesel hammers). Considerable work has been done in developing better representations of the parameters characterizing the components of the hammer assembly-pile-soil system shown in Figure 1.

Dynamic Monitoring Methods

The determination of hammer "efficiency" was a major uncertainty in applying any dynamic method. Impact driving forces were measured successfully as early as the 1930s. The Michigan State Highway Commission published the results of an extensive test program in 1965. Research beginning in the 1960s at Case Western Reserve University and the University of Illinois, focused on evaluations of hammer performance. The growing use of diesel hammers provided much of the impetus for these research studies, as the thermodynamic phenomena were not simulated in the original wave equation (Smith) algorithms.

The CWRU research results entered foundation engineering practice beginning in 1972, when the first Pile Driving Analyzer (PDA) was sold. Today, the Case-Goble methods are applied by consultants, contractors, and various agencies world wide. Pile Dynamics, Inc., Cleveland, Ohio, and a handful of lesser competitors, sell PC-based measurement and analysis systems which gather data, process and report results of dynamic monitoring events immediately on-site. More than 200 PDA-type systems exist, with half of these located in the United States.

In addition to hammer performance information, the simultaneous acquisition of both force and acceleration records provides a wealth of information. The integrity of the pile and the soil resistance forces encountered by the blow, can be derived from the measured data, and examined immediately in the field.

Detailed Analyses

Enhanced digital storage capabilities permit recording of PDA-computed results and time histories (force and velocity) for selected hammer blows for subsequent study. The time histories may be introduced at the pile head (in place of the hammer model), and analyzed in a one-dimensional wave equation algorithm.

TABLE 1
Comparison of Dynamic Methods (after Parolo, 1970)

ENERGY FORMULA	VARIABLES					
	Pile Stfness	Hammer Cushion	Pile Resist Cushion Dist.	Hammer Energy	Ram Velocity	Drivehead Weight
1. Engineering News				X		
2. Mod. Engrg News	U			X		
3. Gow	U			X		
4. Vulcan Iron Works	U			X		
5. Bureau of Yards & Docks				X		
6. Rankine			X	X		
7. Dutch	U			X		
8. Ritter	U			X		
9. Eytelwein	U			X		
10. Navy-McKay	U			X		
11. Gates				X		
12. Danish	X			X		
13. Janbu	X			X		
14. Niley	X		X	X		
15. Pac. Coast UBC	X			X		
16. Canadian Nat. Bldg. Code	X		X	X		
17. Olson & Flaate				X		
Wave Equation Method	X	X	X	X	X	X

Legend: Blank Space -- variable not considered
U -- variable use unsatisfactory
X -- variable accounted for properly

Table 1

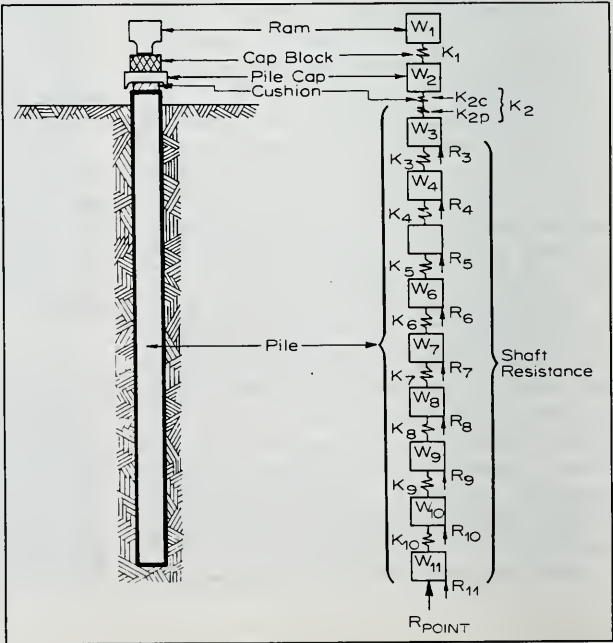


Figure 1

Solution results include the distribution of resistance forces along the pile encountered by the hammer blow.

The CAPWAP computer program, developed by Professor Goble and his colleagues at CWRU, is the most commonly used analysis method. In 1988 there were less than 20 organizations worldwide performing CAPWAP or similar programs.

LIST OF FIGURES

1. Wave Equation Discrete Element Model
2. Prefield Pile Driveability Evaluation
3. Site Plan
4. Profile A-A
5. Results from CPT3
6. Comparison of CPT and SPT Results
7. Comparison of Predicted and Measured Capacity, TP1
8. Comparison of Predicted and Measured Load-Settlement, TP1
9. Capacity Gain with Time in Cohesive Soils (after Vesic)

Insitu Testing

The limitations of conventional exploratory borings and laboratory testing methods are well recognized in geotechnical engineering practice. The introduction of the electronic cone penetrometer test (CPT) in the early 1970s provided a powerful tool for use by foundation engineers. In addition to better characterization of subsurface stratigraphy, reasonably good correlations were developed between CPT-measured parameters and engineering properties. As a "model" pile, the correlations between CPT data and axial pile behavior (capacity and driveability) have proven reliable in many geologic settings.

Significant Project Events

From a foundation engineering viewpoint, a piling project ideally includes the steps outlined in Table 2. On major projects, each of these steps is formally executed to some degree. For rehabilitation or expansion of existing facilities, a common scenario in present day railroad and infrastructure work, these steps should have been part of the design/build process for the original facilities.

In cases where existing facilities are involved, a "detective" phase should be inserted near the top of Table 2. Detailed evaluations of available design, construction and perfor-

SIGNIFICANT EVENTS PILE FOUNDATION PROJECT

EXPLORATION TESTING

- Two Phase Program

PRELIMINARY DESIGN RECOMMENDATIONS

- Estimate Structural Loads, Tolerable Settlements
- Select Candidate Pile(s) and Configuration(s)
- Estimate Capacity, Settlement, Deflection
- Estimate Required Penetration/Installation Criteria
- Develop Indicator Pile Driving and Load Testing Program

INDICATOR PILE INSTALLATION

- Initial Driving
- Restrike
- Dynamic Measurements

LOAD TESTING

- Axial
- Lateral

INTERPRETATION OF FIELD DATA

- Refusal Conditions
- Ultimate Pile Capacities, Settlement, Group Effects
- Correlation of Dynamic Measurements with Analyses
- Load Transfer Behavior Characterization

FINAL DESIGN RECOMMENDATIONS

CONSTRUCTION MONITORING, INSPECTION, MODIFICATION

Table 2

mance information of the original structures, would satisfy much of the engineering effort suggested in Table 2.

On projects involving "new" conditions (geotechnical, structural, and/or pile installation system), or lacking information on the previous/adjacent project, the process described in Table 2 should be followed. The dynamic methods described in this paper are effectively applied in an indicator pile test program. Good estimation of pile lengths required is usually an important design concern. (This is essential for precast, prestressed concrete piles.) The need for penetration aids (jetting or predrilling), and assessment of their effects on foundation performance, is often the focus of indicator pile test programs.

The behavior of soils in response to pile installation operations, deserve particular attention. It has become clear to designers in recent years that the resistance mobilized during pile installation rarely represents the behavior under

service loading conditions. In many cases pile capacity increases with time (soil freeze or setup), such that resistance estimates based on installation blowcounts can be very conservative. Under some conditions the soils actually lose resistance to penetration following installation (relaxation) which may prove unconservative for design purposes.

These factors led to ASTM Standards stipulations that static load tests be performed at least five days after pile installation. In order to correlate pile capacity estimates using dynamic methods with static testing results, it is essential that restrike driving events be employed.

Once field and laboratory testing results are systematically interpreted, installation criteria and design recommendations are finalized. Dynamic monitoring efforts during production pile driving can facilitate remedial actions should unforeseen conditions arise. Barriers between designers and builders, contractual or organizational, are the most common and costly problems encountered in present day piling practice. Careful observations by the foundation engineer throughout construction yields substantial cost/time benefits on most piling projects when unforeseen conditions arise.

Case Histories

Prefield Wave Equation Studies

As a matter of course, we commonly perform wave equation analyses of the pile installation process. A pre-bid study was performed for a piling contractor to help him examine alternatives meeting the specifications for a large project in southern California. Ten thousand piles were designed for a new facility, and the installation criteria were specified according to the Engineering News formula.

The designer stipulated that a maximum rated energy of at least 670,000 feet per pound was required. Our contractor had his own Kobe KB 60, but was considering renting a Delmag D62-02; both are single-acting diesel hammers. The first air/steam hammer meeting the energy requirements was the single-acting Vulcan 020.

The results shown in Figure 2 simulate the installation of a 115 foot long PCPS concrete pile, having a 24 inch octagonal cross section. Resistance is developed primarily through end-bearing in dense Pleistocene sands. These soils were known to exhibit "large toe quake" condi-

tions, which require larger "elastic" penetration at the pile toe before permanent set is achieved. In simplest terms, considerable greater energy must be delivered at the pile toe to cause permanent set in such cases, in comparison with "normal" quake soils. Or in other terms, for a

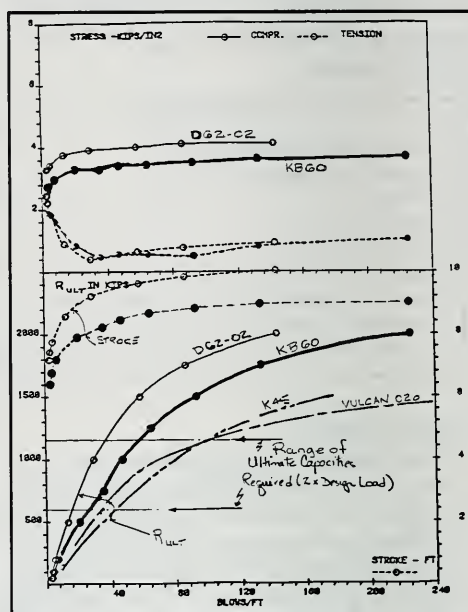


Figure 2

given hammer the bearing capacity at refusal blowcounts is appreciably reduced by large quake conditions.

The lower portion of Figure 2 shows the bearing curves (capacity R_{UT} versus blowcount) for the two diesel hammers meeting the project specifications, along with those for the Vulcan 020 and a Kobe K45 diesel hammer (less than 60,000 feet per pound maximum rated energy). The two larger diesel hammers (D62-02 and KB60) cover the range of required ultimate capacities (600 to 1150 kips) at nominal blowcount levels. Within a normal range of hammer performance, either one of these hammers is well suited to these design/site requirements. The contractor had to weigh the cycle time economies against the added rental costs in the bidding process.

The Vulcan 020, on the other hand, labors at blowcounts approaching 120 blows per foot for piles at the upper end of the ultimate capacity

range. The flat bearing curve at higher blow-counts is readily apparent. At lesser hammer performance levels, this hammer would be unable to overcome the 1150 kip resistance requirements at this site. Interestingly, the smaller K45 hammer would perform at least as well as the Vulcan 020 in the higher resistance range, according to these analysis results.

The successful bidder immediately purchased three new Vulcan 020 hammers to do this project. Following an indicator pile monitoring and analysis program by others, the high toe quake behavior was confirmed at this site. Somewhat poorer hammer performance (in comparison with that assumed in these analyses) was also noted. Final blowcount criteria in excess of 240 blows per foot were established for the highest capacity piles on this project.

Field Test Programs

Design Study

A recent investigation for an office complex in the Santa Clara Valley in northern California illustrates the design application of modern exploration and dynamic monitoring methods. This case history is described in more detail elsewhere (Holloway and Romig, 1988).

A plan drawing of the project site, Figure 3, depicts three office towers, interconnected by low-rise commercial space and adjacent parking facilities. Eight conventional borings (sampling and laboratory testing) and 15 CPTs were performed at select locations across the site. Cross section A-A, shown in Figure 4, reveals dense granular strata (C and E) interbedded with cohesive deposits. For this presentation, results from CPT3 and Test Pile 1 (TPI) will be reviewed in detail.

A plot of CPT3 results in Figure 5 provides tip resistance (q_c), friction ratio ($FR = q_c/\text{sleeve resistance}$, in percent), and differential pore pressure ratio ($DPPR = \text{dynamic pore pressure behind the cone tip}/q_c$, in percent) versus depth. Dense sands and gravels (strata C and E) exhibit high q_c , low FR , and negative $DPPR$ values in this figure. Stiff cohesive soils have lesser q_c values and attendant higher FR values than the granular materials. In addition to pile capacity evaluations of CPT data, it is possible to convert these results to equivalent SPT N values as shown in Figure 6. Agreement between CPT-computed and measured SPT data from nearby borings is quite good.

Based on the geotechnical information thus obtained, preliminary pile lengths were selected

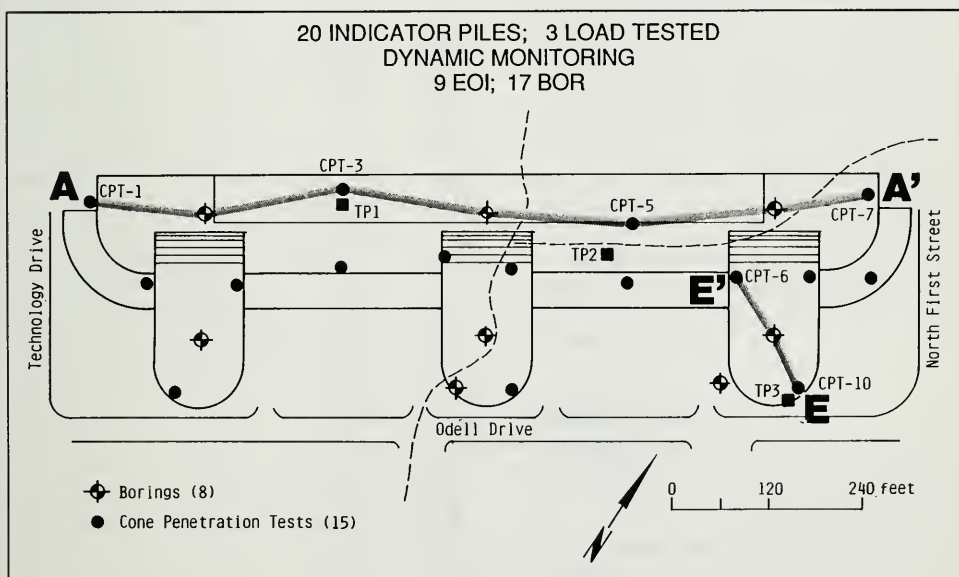


Figure 3

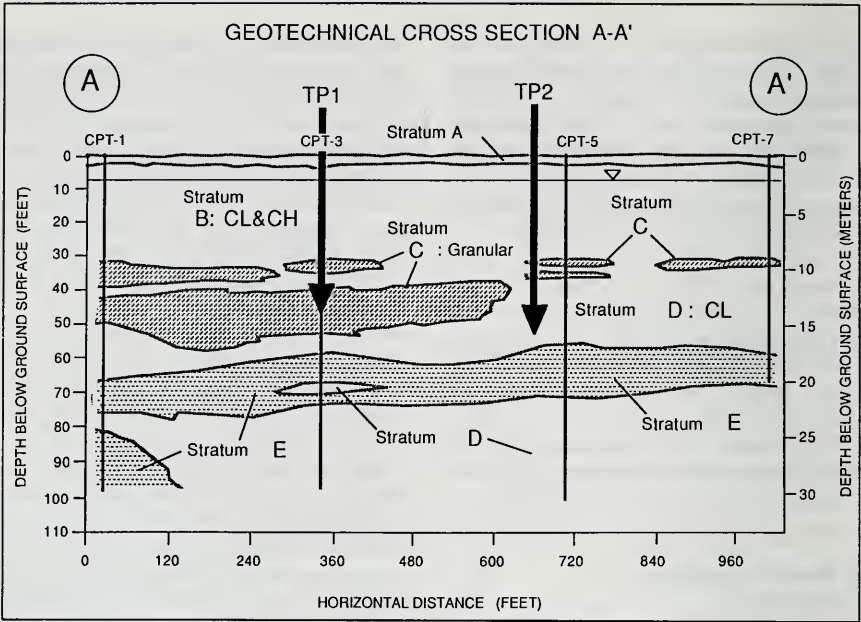


Figure 4

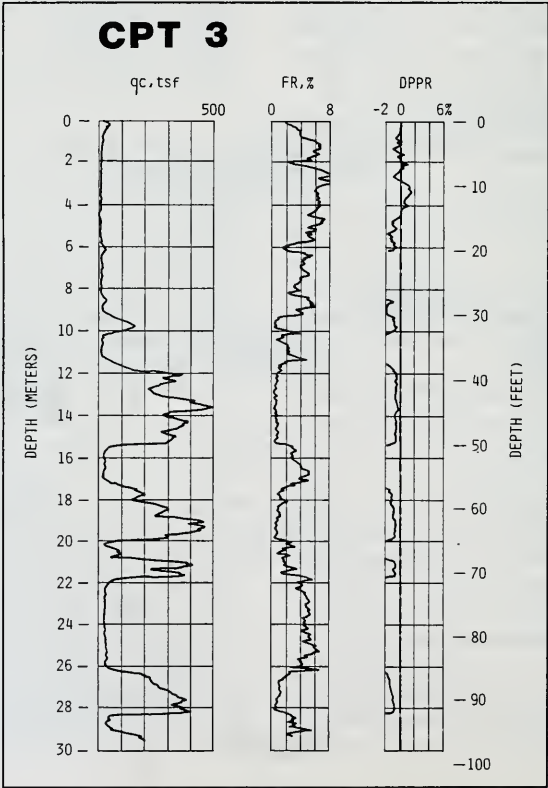


Figure 5

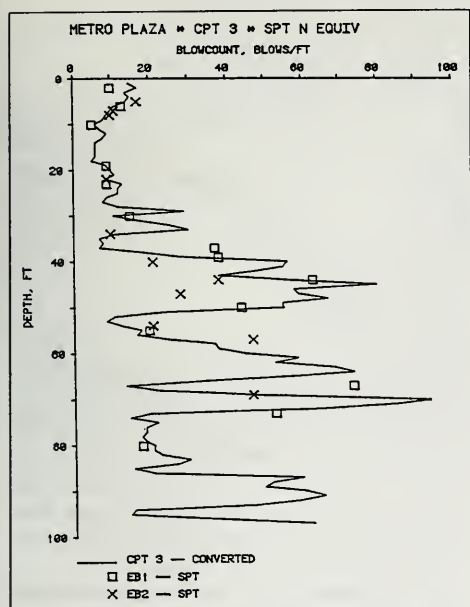


Figure 6

and provided in the bid documents. Final pile design and installation criteria were to be derived from the indicator pile driving and load test program, performed at the beginning of the production pile installation contract.

Twenty indicator piles were identified in the project plans, distributed across the site. All the indicator piles were placed at production pile locations. Nine indicator piles were monitored at the end of installation (EOI), verifying satisfactory pile driver performance. Static load tests were performed on three piles. Seventeen indicator piles (two of which were statically tested previously), were monitored at the beginning of restrike (BOR).

Pile capacity estimates for TP1, as a function of depth, are given in Figure 7 along with data from the static load test. Both the CPT-calculated values and those from dynamic monitoring program predict static test results remarkably well. Predicted and measured load-settlement behavior are presented in Figure 8. Good agreement from these and other load test pile comparisons at this site permitted confident extrapolation of CPT and restrike monitoring estimates of pile capacity to the remaining locations for use in finalizing pile penetration requirements.

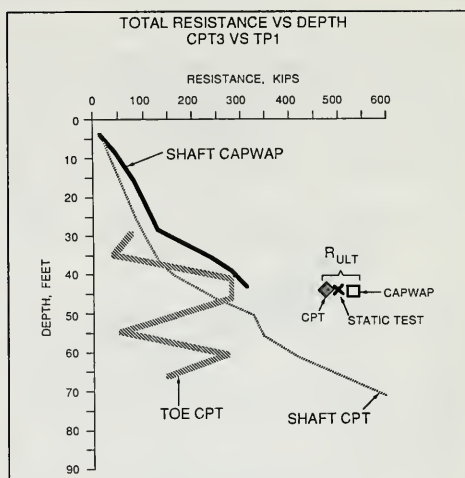


Figure 7

Capacity Gain With Time

Sensitive cohesive soils often exhibit substantial strength increases with time after pile installation. In the San Francisco Bay Area, marine and alluvial clays yield three-to six-fold increases in shaft resistance with time following pile installation. The percent of maximum (measured) capacity is plotted versus log of time elapsed since driving in Figure 9, for load tested piles in cohesive piles from a number of sites around the world. Test results from the Santa Clara Valley, described above, correlated well with the SC Valley line shown in Figure 9.

It is interesting to note from the test program described above, we had the opportunity to restrike one of these indicator piles two months after driving. The pile had gained still more soil resistance with time. As such, the friction capacities derived from restrike results at this site are clearly lower-bound estimates of the capacity levels expected under service loading conditions.

Usage Guidelines

Dynamic methods are listed by degree of usage confidence in Table 3. Wave equation analyses of pile driving problems are as far away as your personal computer. Fully documented help menus, program input templates, and graphics output features greatly facilitate usage by novice and expert alike. Many common issues can be identified and resolved long

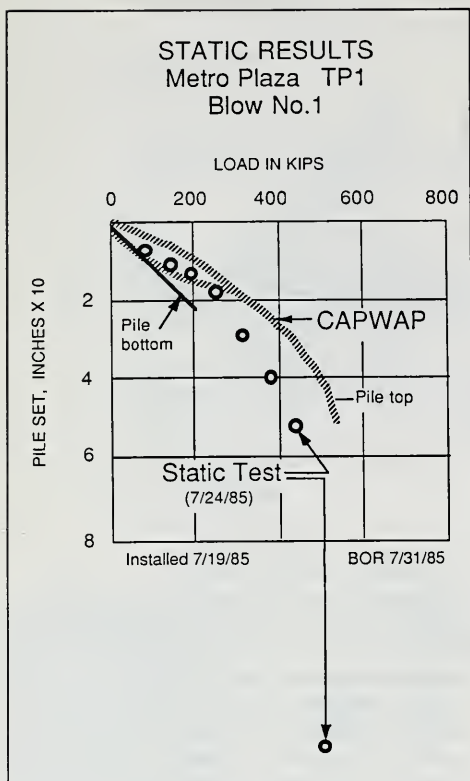


Figure 8

before the field work begins.

In assessments of hammer performance and pile integrity, dynamic measurements are required. A broken pile is easily detected from PDA measurements of force and velocity. For a damaged pile, quantitative information concerning the degree of pile damage usually requires CAPWAP or similar analyses.

For estimating pile capacity by dynamic methods, it is imperative that restrike results be used. Energy formulae are the simplest methods to use; however, they usually provide the least reliable results. In cases where good correlations between load test results and restrike blowcounts have been developed (for the same combination of hammer/cushion/pile soil conditions), confidence is substantially improved with any of the methods.

Once outside the "comfort zone" of your correlations or experience base, thorough analysis of field-measured restrike behavior offers the best approach to pile capacity determinations.

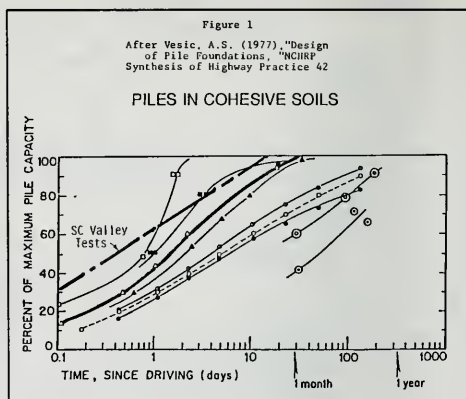


Figure 9

In unfamiliar circumstances, static pile load tests to failure are essential to confirm the reliability of dynamic solution method.

The estimation of soil resistance distribution detected by a hammer blow can only be obtained from detailed analyses. As these analysis methods provide approximate solutions to the true resistance rheology, detailed stratigraphic information may be needed to accurately depict resistance force distribution.

Conclusions and Recommendations

Modern dynamic methods afford substantial improvements over those in use 100 years ago. The AREA Manual for Railway Engineering provides practical guidance on these subjects in Part 4 — Pile Foundations. It is a useful reference for use in approaching pile foundation projects.

Improvements in pile driving equipment and installation techniques have barely kept pace with increased demands (for example, higher capacity requirements) of these foundation elements. Fortunately, prediction methods modeling the behavior of impact-driven piles, during installation and under service loads, also have improved markedly in the past three decades. The true margins of safety are shrinking as we take full advantage of long-term capacity gains on many sites. Field testing to confirm or modify foundation designs and installation criteria has become an essential component of piling practice.

Railroad builders played an innovative role in shaping piling practice in the century past.

TABLE 3
Levels of Usage Confidence

METHOD	Capacity*	Integrity	Hammer Performance	Soil Resistance Distribution
Energy Formulae	4			
Wave Equation	3		3	
Pile Driving Analyzer	2	2	1	
Detailed Analyses	1	1		2

* Restrike Events

RELIABILITY
4 = LEAST
1 = MOST

Your leadership is needed in applying improved methods of subsurface exploration, pile behavior modeling, and field performance evaluation to maintain and expand our transportation systems to meet our society's needs in the coming century.

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Mr. Saletnik: I would like to call Don McCammon to the podium to introduce the next special subject.

Mr. McCammon: First of all I would like to thank Tim Rich and Doug Williams of Conrail who acted as co-chairmen of special subject No. 2, Culverts - Maintenance and Repair. I'm going to introduce you to Tim Rich who will be making the presentation this afternoon.

Tim Rich is currently the engineer of bridges and buildings for Conrail located in Harrisburg, Pennsylvania. He graduated from the University of Kentucky at Lexington with a B.S. degree in civil engineering and was hired into Conrail's engineering management program. He worked as an assistant supervisor of structures and was involved with the capital replacement of 15 bridges, so he got into hot water right quick. He went on to senior structural inspector in Philadelphia and then to his present position as the engineer of bridges and buildings. Tim.

SPECIAL SUBJECT NO. 2

CULVERTS—MAINTENANCE AND REPAIR

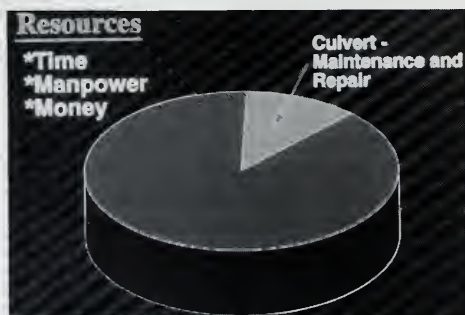
Co-Chairmen: T. Rich, Engr.-B&B, Conrail, Harrisburg PA
D. E. Williams, Engr.-Strs., Conrail, Dearborn MI

Committee: F. K. Haugen, Supv.-B&B, BN, Englewood CO
R. Wolzen, Supv.-B&B, BN, Alliance NE
B. R. Anderson, Qlty. Council, Conrail, Harrisburg PA
J. R. Morbitzer, Br. Supv., Conrail, Columbus OH
J. L. Neece, Supv.-B&B, CSX, Helena AL
G. C. Davis, Rdmstr., McCloud River RR, McCloud CA
N. J. Higgins, Engr. Tech., Ontario Northland RY, North Bay ONT
R. C. Karsten, B&B Utility Supv., SP Lines, Liberty MO
R. Purvis, Dir.-Strs., Wilbur Smith Associates, Falls Church VA

Introduction

"Culverts—Maintenance and Repair," is a topic that is receiving more and more attention in recent years. Increasing emphasis on economics and manpower have resulted in railroad maintenance-of-way and structure departments continually re-evaluating repair priority lists and economic repair procedures.

The American International Association of Railway Superintendents of Bridges and Buildings reported in St. Louis 100 years ago on the installation of new culverts. This committee will address recommended maintenance and repair of culverts in order to avoid costly renewals and traffic delays. However, before an efficient and economic repair can be made, it may be important to understand the history of that particular culvert.



History

Committee members James Stannard, J. E. Wallace and J. O. Thorne were appointed by the American International Association of Rail-

way Superintendents of Bridges and Buildings to report on iron and vitrified pipes on September 25, 1891.

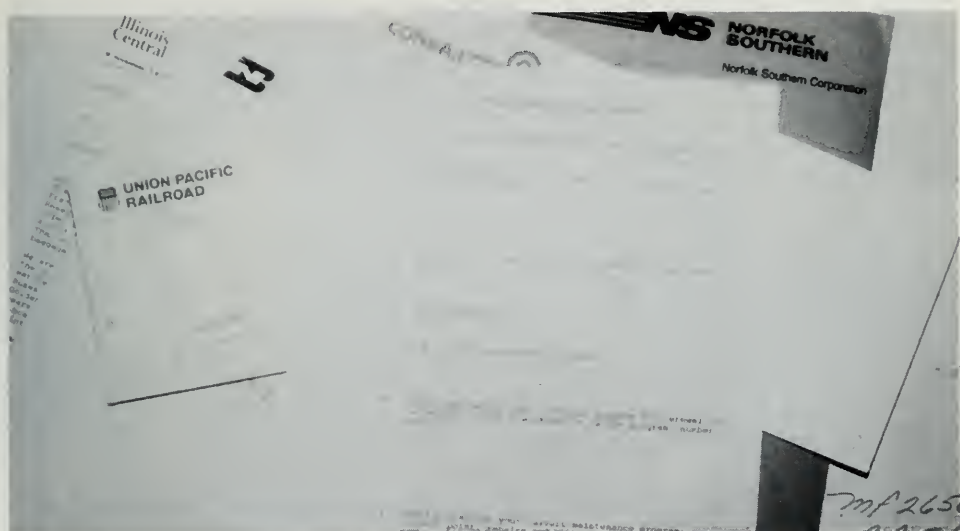
Shown is a typical wooden box culvert. They recommended replacing wood structures with iron pipe in order to eliminate fire hazards. From this view you may also notice the abutment settlement. They chose iron over vitrified because of vitrified pipe's propensity to crack when exposed to freeze/thaw or when cover is limited. In this particular region of the country, these cast iron pipes are susceptible to many freeze/thaw cycles throughout the winter season. The cover from the top of the pipes is also limited. They also chose iron for deep fill installation. They stated that the cost of putting the pipe in position eliminated the cost difference between the pipes as a factor. For this cast iron pipe there is a considerable amount of fill. Both of these pipes were constructed appropriately for that era.

The committee reported that they could not comment on iron pipes' lasting qualities from experience. At that time the railroads were adopting cast iron and having good results.

The committee recommended vitrified pipe when renewing wooden sluice boxes at road crossings because of the cost. They also stated that it could be used successfully for waterways on sidings.

Prioritizing Culverts

The concerns have shifted from new installation to "what part of given resources should be committed to culvert maintenance and repair". As mentioned previously, we will be address-



ing recommended maintenance and repair in order to avoid costly renewals and traffic delays. We will also provide some considerations when examining alternatives.

A questionnaire was sent to various railroads to determine the following:

1. Approximately how many culverts are in your territory?
2. Define what constitutes those culverts for which you are responsible.
3. Are they inspected by bridge inspectors or track patrol?
4. What frequency?
5. How are the inspections recorded?
6. Does your company have a capital program for renewal of culverts? If so, how extensive is the program (number per year)?
7. Briefly describe your culvert maintenance program (clean, point, repairs and type of repairs, renewals, etc.).

Culvert span lengths varied from six inches to 10 feet. Responses for inspection programs were split. Approximately 50 percent were conducted by track personnel and 50 percent by bridge inspectors or supervisors. Very little monies were being spent on replacement and repair programs. In some instances, maintenance was only being performed as a result of crisis management.

Webster defines a culvert simply as "a drain crossing under a road or railroad". This report will address boxes, arches and also pipes which are greater than 24 inches and less than 96-inch

span lengths. Few wooden boxes or brick pipes remain and, in most cases, should be considered for renewal should problems develop.

In any program, determining the severity of problems and affixing priorities is essential. In order to do so, a routine inspection schedule must be established. To guarantee the structures are inspected with experienced logic, we would recommend that the inspections be carried out by those people responsible for your bridge inspection program.

In all cases, the first and most important consideration in culvert maintenance is maintaining maximum flow area. Keeping culverts free of debris and ballast is essential to proper drainage. Flow area is also a major concern in repairs. Some repairs may require a reduction in flow area in order to extend the service life of a structure. If possible, repairs restricting flow should be avoided in an area with a high propensity for fast water. Conditions may require renewal or replacement. The decision to open cut or "jack-a-pipe" is dependent upon local requirements and traffic. In the event resources are not available, it is the responsibility of the maintenance supervisor. It is additionally the supervisor's responsibility to maintain flow. In many instances he may be required to reduce a structure's flow area to maintain structural support until said funding is available. Pictured is a stone box with multiple broken roof stones that was in danger of collapse under a mainline with minimal cover. A corrugated



metal pipe was inserted and grout bags packed in the remaining voids. This is a view from the inside, where the pipe extends into the concrete box section. The flow area was reduced dramatically, but the structural integrity was maintained. In this slide, this roof support retrofit also reduces flow area while maintaining structural integrity. This repair is more susceptible

to collect debris and reduce flow area even more.

Other items to consider when determining priorities and method of repair are: Resources—available manpower and funding; consequences—worst case scenario in the event of a failure; severity—extent of movement or deterioration; traffic—speed and tonnage; loca-



tion—depth of cover and track position; size—feasibility of interior repair; and accessibility—rights-of-way and cover.

To recap, flow area, resources, consequences, severity, traffic, location, size and accessibility are guidelines for prioritizing.

Stone Boxes and Arches

Those structures constructed with stone have become a major source of concern. If not already past, the service life of many of these structures is rapidly coming to an end.

A commitment to programmed maintenance, rather than crisis management, could extend their life expectancy another 20 to 30 years and save enormous renewal costs.

Problems occurring in stone boxes include cracked roof stones, pointing, undermining and deterioration of abutments. Typically, a problem arises in one of these areas, allowing movement which accelerates deterioration. Eventually, problems arise in the other areas, propagating to failure.

Pointing problems allow abutment stones to pump and the wash-out of backfill. Pressure pointing may not be an option when considering the size of the boxes.

Most maintenance programs do not have the resources available for what is thought of as “preventative maintenance”. Progression often leads to abutment deterioration. As you can see, if maintenance and repairs are let go long enough, an entire section of the abutment could collapse. In this particular culvert, eight feet of the abutment has collapsed. Four roof stones

are cantilevered, due to no support on this side. Cracked roof stones and undermining also lead to abutment problems. Once again, size is a major consideration. Severity and accessibility are also major concerns. Isolated problems may be patched. If size allows, benching may be necessary when abutment damage has progressed. An alternative would be to insert a pipe, or liner, and pump grout. As seen, this double stone box had pipes inserted and grouted. You can also see the new precast parapet. Inserting two pipes, as shown, is not an acceptable repair. It will not increase the structural integrity and it will cause debris to plug the culvert.

Cracked roof stones are commonly repaired by providing additional support with rail sections. To insert roof rails, a minimum of a three-foot span is required, so for this type of repair, once again size becomes a factor. This type of repair is highly susceptible to point loading so adequate bearing area on the abutment stone should be provided. They should be shimmed tight, then epoxied or grouted. These rail sections should be inspected for section loss due to corrosion as part of the routine culvert inspection. An alternative would be excavating and installing a steel plate.

Problems with undermining are correctable by providing the necessary flooring and apron. Should voids exist, pumping grout is recommended.

Illustrated is an isolated area of the problems with pointing and abutments. Size was not a factor, therefore, a concrete patch was the appropriate repair. Undermining is also com-



mon to stone arches. Arches may also experience separation due to the pushing of the spandrels in freeze/thaws or excessive lateral loading. Arch design, as such, is that all members are in compression. Maintenance is more crucial in arches than with a box because the deterioration and failure is more rapid. Repair after a failure is also more difficult and costly.

Should the upkeep of pointing not be included in basic maintenance programs, flattening of the arch could occur and/or arch stones could begin to fall out. In either case, the condition will progress to failure. Stones have fallen from the keystone area of this stone arch. Typically, restrictions due to size are not a factor. Sometimes an arch's integrity can be temporarily maintained with timber wedges until pressure-pointed. These wedges temporarily restore compression to the adjacent stones. Should maintenance be deferred and deformation and/or localized failure occur, a liner or shotcreting may be required.

Notice the loose stone in this slide. In shotcreting, first a wire mesh is anchored to the stone arch. On the left, you can see a completed section that has been shotcreted.

Problems with abutment stone erosion, scour and undermining are common problems and can be corrected with benches, flooring and aprons. Care must be taken to ensure the filling of voids, particularly when the arch is constructed with small stones. Voids can normally be located by "sounding" the arch with a blunt object.

Ring separation and similar arch cracking due to lateral movement should be marked discreetly and monitored by inspectors. If the movement continues or the spandrels begin to push off, repairs should be programmed. When considering the size parameters given, buttress walls are probably the most permanent and economical solution.

Concrete Boxes and Arches

Common problems with concrete structures are spalling, undermining and lateral movement of headwalls. Failure is typically much slower than with stone and less of a threat to traffic. Additional considerations include the amount and condition of the concrete remaining and the use and condition of the rebar.

Flooring, benches, shotcreting and buttresses are, as with stone structures, recommended repairs. Should cracks develop lateral to the track, consideration should be given to installing a pipe, pipe arch or liner and pump-jacking grout.

Pipes

Pull-aparts are the most common problems with pipes. End sections can be reset when settled. If resources are available, further problems can be prevented by either extending the pipe or building a headwall, as shown. This particu-



lar pipe was extended and a small headwall added. However, this next slide is not a recommended technique when building headwalls. This addition and surcharge often causes a pipe separation. An interior band is also a recommended repair for the short term. If settlement continues, the band may be disrupted. "Throwing a bag of Sakrete in a hole" may be a temporary cure, but problems will reoccur. Excavating isolated areas and plating is more permanent. If multiple separations exist in one pipe, sleeving a pipe should be considered.

Corrosion due to alkalide or acidic conditions is a problem in some areas. This corrugated metal pipe, as shown, was in service only seven months. The stream had a PH of 3.2, very acidic. If total replacement is required, corrugated plastic can be used up to 36 inches in diameter and reinforced fiberglass pipe for diameters greater than 36 inches.

Conclusion

In closing, we have recommended an inspection program, prioritization of repairs and some possible cost-efficient retrofit procedures based on today's technologies and service life of culverts.

Over the past 100 years, the discussions have changed from new culvert installations to "what resources should be devoted to culvert maintenance and repair". Materials have progressed from wood and cast iron to high-strength steel and precast concrete. It would be interesting, to say the least, to know what new problems and

solutions are developed over the next 100 years from the use of what is now considered sophisticated material and construction procedures.

Thank you. (Applause)

President Horney: Thank you, Tim. Tim referred a couple of times in his presentation to the 1891 conference or presentations and papers that were made at that time. It's interesting and I'd like to have you note that the four special subjects we have this year are very similar to the ones that were presented in 1891, such as the restoration and reinforcement of timber bridges, and the the culvert presentation you just heard. We'll have one on facilities and also on painting and protection of steel structures. We still have similar problems today as we did 100 years ago, but we have just a little different answers.

I'd like to thank everyone who made presentations this afternoon. Before we adjourn I'd like to have you take a look at the special subject cards. They have the 1992 subjects on them and the presentations and the credibility and the quality are directly related to the help from the members. That's you folks and the folks out there who were unable to be here but who still participate. If you have contributions to these subjects, please fill out the cards and turn them in at the registration desk.

We will meet tomorrow morning at 8:30 in joint session with the Roadmasters. Today's session stands adjourned. Thank you very much. (Applause)

Adjourned

TUESDAY MORNING JOINT SESSION

September 24, 1991

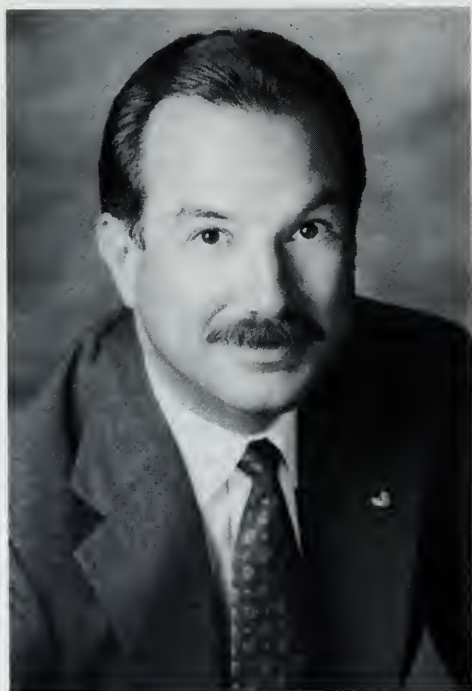
President Cossel: The second joint session of the Roadmasters and Maintenance of Way Association and the American Railway Bridge and Building Association will now come to order.

Ladies and gentlemen, members and guests, on behalf of the Roadmasters and Maintenance of Way Association of America and the American Railway Bridge and Building Association, I welcome you to the second joint session of this conference here in St. Louis. The registration this morning is 183 Roadmasters, 119 B&B, 263 Associates, 114 spouses/guests for a grand total of 679.

At this time I would like to introduce Dave LeVan, senior vice president corporate systems with Conrail. Dave received his B.A. in business administration from Gettysburg College in 1968 and attended the Advanced Management Program at Harvard University in 1987. He began his career with Coopers and Lybrand in 1968. He became assistant controller general accounting with Conrail in 1978, advancing through the finance area. In 1988 he became vice president corporate strategy and in 1990 he was appointed to his present position of senior vice president corporate systems.

KEYNOTE ADDRESS

David LeVan



David LeVan

Good morning. My thanks to Jerry Cossel for the opportunity to talk to you this morning. Jim Hagen would have been here but he had to be at the National Freight meeting. I'd like to share with you some thoughts about the rail industry's prospects in the short term, but more importantly, talk about the challenges of how we need to manage railroads over the next several years to build a prosperous future for the industry.

Many of you here today have seen enormous change in this business, even in the last decade, and whether you are an optimist or a pessimist about the rail industry's prospects, both in the next few months and into the next century, might depend on how much experience you have as a railroader. Mark Twain, who lived much of his life just up the river in Hannibal, Missouri, said, "The man who is a pessimist before 48 knows too much; the man who is an optimist after 48 knows too little." Personally, I have two years to reach that magic age, so my optimism suggests that I don't know too much.

Well, whether you know too much or too little about the railroad business, we can all be somewhat optimistic about the short-term outlook. The recovery seems to be upon us, and

even though it's a sluggish one, we can probably look for the first half of next year to produce some welcome increases in rail traffic compared to the tough months we weathered early this year. The biggest question mark that exists is automobile sales—whether it, and with it, our finished vehicles and parts traffic, will turn up as we head into the first half of 1992. A vigorous recovery of our higher-margin businesses, like automotive, could make unabashed optimists of us all.

But as we have discovered since 1980, a strong economy doesn't guarantee growth in the share of the transportation market captured by railroads. During the 1980s, with the longest postwar upturn in history, railroads lost billions of dollars in market share to trucks because trucks learned to do the things that customers wanted them to do.

Before we reach the new century, we need to match or exceed our competitors' ability to satisfy the transportation marketplace. As an industry, we need to provide an integrated, door-to-door transportation product. We need to be responsive and resourceful enough to adjust that product to customers' changing needs and, you know as well as I do, those needs change daily and we need to back that product up with timely, useful information.

So where are we in relation to that goal, and how do we get there? Right now, we're an industry that does some things very well and other things just well enough to get by. But "well enough to get by" is just another way of saying "not good enough." There are lots of other things that just plain need improvement. Based on Conrail's experience, for example, we believe our ability to move freight from Point A to Point B is superior, but when we try to bill a customer for that service, that bill is going to be inaccurate one or two times out of ten. Think about how many bills a railroad of Class I size issues in a year's time. We are talking about a lot of work just to resolve inaccurate bills, and think of the frustration of our customers.

So the job is before us, but we have the tools to do it. We have technological potential and we have people potential. We can combine the two to change the way we manage our business and eliminate the barriers that stand between us and that goal, that integrated, flexible, solidly backed product I mentioned before.

Indeed, the way we think of "managing" rail-

roads is already evolving, led by the realization that quality is the fuel that will propel us forward. Many railroads—including Conrail—have adopted a rigorous approach to improving the processes by which work is performed in our organizations, hence improving the quality of the finished product. If it is happening at your railroad, you know that this approach is meant to touch every aspect of the business and every employee.

At Conrail, we're calling this approach Continuous Quality Improvement. At its core is Conrail's vision of being the carrier of choice in the markets we serve. That choice can only be made by the customer, based on the customer's standards. So when customers choose Conrail, instead of one of our over-the-highway competitors, they do it because we have proven our ability to exceed the standards they apply.

Let me list the attributes of world class companies that were set out in the September 23 issue of *Fortune* magazine. They:

- Set the performance standards
- Care passionately about delivering quality to customers
- Are market-driven
- Respond quickly to change
- Have a vision, and a strategy to make it happen
- Think globally, but act locally
- Are not satisfied with the status quo
- Focus on quality
- Empower their employees
- Are good corporate citizens
- Think beyond quality

Our customers are some of these world class companies. Unfortunately, many world class companies avoid rail transportation. Is Conrail a world class company by these standards? I'd be kidding you and myself if I answered yes. This is a long journey of change, and we are just taking the first steps.

We couldn't dream of succeeding in this approach without another shift in the notion of how to manage railroads: That the top-down hierarchy that has guided our decision making for so long, now stands in our way. We replace the old notion with a new philosophy that recognizes the potential for improving our business that can come from employees, like yourselves, who know their jobs better than anyone else: empowerment. Give railroad people the opportunity and the skills to poke around under

the hood, try new ideas, do things they believe will make them—and the organization—more productive, more responsive, more customer-focused.

Many companies in many different industries make a point of proclaiming that their employees are their greatest resource. Some mean it, some don't, but railroads can't afford to allow that idea to become another case of lip service, however well-intended it might be. The industry has too much at stake over the next several years to squander the good ideas and the years of experience that you and your co-workers at all levels of the business can contribute.

Another change in the way railroads are being managed is that we can accomplish greater results more quickly by working in teams that span functional boundaries, an approach that has been labeled "management by networks." Again, that challenges the traditional notice of chain-of-command style management that has been with us since the first mile of track was built more than a hundred years ago.

The approach makes sense though, doesn't it? Think about how many problems that you encounter that cannot be solved without input and assistance from someone in another department. At its most cumbersome state, traditional railroad management dictates that many decisions that cross functional boundaries have to travel up the hierarchy until they reach a level high enough that someone can push them over the wall to the other department. It takes time and it ties up management resources that are in short supply these days.

Working in teams, networks, that break these functional barriers, we can do the work we need to do to operate the railroad today and plan for its future, and we can do it at the most efficient level. We can also involve those whose input is crucial to making effective business decisions, and do it without traveling up and down a cumbersome structural ladder.

Take for instance the effect coordination, or a lack of it, between the marketing department and various parts of the operating department has on day-to-day service options, and more importantly, on long-range planning decisions. The maintenance-of-way people here know how difficult it can be to get a busy section of track taken out of service for required maintenance. One effective coordination and informa-

tion flow between maintenance of way, transportation and marketing can secure that section of track for maintenance without adversely affecting transportation operations or the customers whose traffic moves over that line.

That's just one isolated example. Now consider how difficult it would be to plan strategically, several years into the future, without that cross-functional exchange of ideas and information. You already know how tough your job would be. Imagine you are a marketing person trying to assess the potential for growing traffic without a firm grasp of the future scope of your railroad's transportation operations. Or imagine yourself in transportation, trying to plan rail service with no idea of the needs of your railroad's customers. It is a recipe for failure.

Spreading this network approach to the entire industry makes railroads even more competitive with trucks by creating the ability to provide "seamless service"—where our customers' shipments appear to move over a single integrated system, blurring the boundaries between railroads and other modes of transportation.

We exchange many carloads. Some railroads, Conrail included, have built strong interline partnerships in specific transportation lanes, but the idea of railroads viewing each other as strategic partners is still in its growth stages, and to provide truly seamless service we need to consider ourselves as providing our customers with not just transportation service, but also with accurate, useful information. The technology necessary to achieve that vision—EDI, computerized joint rate systems, interline tracking of shipments and car scheduling and performance systems—is developing quickly. As a result, we add to our ability to exchange freight the capacity to do many things truckers can already do: respond to customer requests quickly with an accurate rate, tell customers where their shipments are and when they will arrive, and bill them correctly.

Obviously, the key to the future of the rail industry will be our ability to locate new sources of traffic to generate those revenues, and in that search, too, we have to move beyond the confines of the traditional rail industry-type commodities. Where are those non-traditional markets?

Solid waste represents a major opportunity for rail carriers, particularly those like Conrail that serve markets where landfill space is

already at a premium. Some major Northeastern cities are sending their trash hundreds of miles in trucks to find available landfills and paying dearly for it. The sheer economic advantage we possess in moving bulk commodities long distances makes solid waste an ideal market for rails to develop over the next several years.

We have to be aggressive in going after short-haul traffic, as well. Traditionally, railroads have been shut out of short distance moves, even in commodities that seem tailored to rail. Aggregates, for example, a heavy-loading bulk commodity, move mostly short distances from quarries to asphalt plants or construction sites, out of the reach of our scheduled service. But with a system of dedicated moves using fast-dumping equipment we can capture some of that traffic, turn equipment quickly, and in some cases make ourselves even more attractive by backhauling construction fill.

There are other markets that we can tap over the next several years if we can develop innovative ways of serving them, ways that add new value to our basic competitive advantage: economical, long-haul, volume transportation.

You're going to hear this morning about the potential from Canadian and Mexican free-trade initiatives.

Let me talk a little bit about change. In 1954, Roger Bannister won world acclaim for breaking the four-minute mile. Today, they do that in high school. The standards are always changing. I wouldn't suggest you try this at home. I haven't tested it personally, but there is a classic physiological phenomenon involving two alternative methods of boiling a live frog. One is that in dropping the frog into boiling water, it will hop right out. But if you place the frog in cold water and gradually raise the temperature, it will just sit there and boil to death. The frog fails to adjust, ignoring a gradual but critical change in its environment.

So if we are working harder than ever these days, but the water is getting hotter, our problem may not be the recession. We may be ignoring the critical change around us.

Incrementally fixing the old broken bureaucracy just isn't working. What is required is quantum ideas for products and services, as well as revolutionary changes in organization to produce them, along with the guts to stick with them. Industry after industry is finding itself in

hot water, and it has grown too late to jump. The computer industry, for example, is feeling the heat. IBM is far from boiled, but the heat is rising.

Change. We can deny that the change is taking place, or we can allow ourselves to be frozen in place by the fear of change.

The right answer is to recognize the need for change and approach it with good old-fashioned smart management and confidence.

Early on, I mentioned that I thought we could be optimistic about the short-term. If the type of rail industry I have described today develops into reality, I have no qualms about showing optimism for our long-term as well, even after I reach age 48.

With the power of the marketplace, the power of the people, the power of information, and the confidence and the ability to work together as networks within our companies, I am confident that we have a tremendous future. Thank you. (Applause)

President Cossel: Thank you very much, Dave. At this time I would like to turn the program over to Paul Saletnik who will introduce the next presentation.

Mr. Saletnik: Thank you, Jerry. This morning's special feature presentation is on St. Louis bridges over the Mississippi and covers four bridges, the Eads Bridge, Merchants Bridge, MacArthur Bridge and the Union Depot Connecting Bridge. The presentation will be chaired by two distinguished gentlemen. Mr. Bill Gilbert, chief engineer of the Terminal Railroad Association will present the first part on the Eads, Merchants and MacArthur bridges and Mr. Robert J. McCann, president of Midwest Mobile Crane, will talk about the Union Depot Connecting Bridge.

Mr. McCann is a 1975 graduate of McPherson College and has worked as a district manager for E. F. Johnson Company designing radio communication systems for the railroad and other industries. From 1979 to 1984 he was vice president of Hulcher Professional Services. In 1984 he became national account manager for Heritage Environmental Services working with the rail industry on a national basis. In 1989 Mr. McCann founded Midwest Mobile Cranes, a rerailling service which has since expanded into crane repair and rebuilding. In 1990 he formed Midwest Environmental Services specializing in the remediation of diesel

fuel and contaminated soils on railroad property.

Bill Gilbert began his railroad career on summer break in 1959 as a rodman for the Minneapolis and St. Louis Railway. He graduated in 1960 with a Bachelor of Science degree in civil engineering from the Missouri School of Mines and Metallurgy at Rolla and upon graduation he joined the Chicago Great Western Railway. In 1962 he joined the New York Cen-

tral Railroad. From there he became engineer of track for the Richmond, Fredricksburg and Potomac Railroad. In 1974 he joined a large railroad construction company involved in the construction of transit systems in Washington, Philadelphia, Pittsburgh, Boston and Baltimore. He became chief engineer of the Terminal Railroad Association of St. Louis, his present position, in 1984. Mr. Gilbert.

ST. LOUIS BRIDGES OVER THE MISSISSIPPI

William J. Gilbert

**Chief Engineer
Terminal Railroad Association**



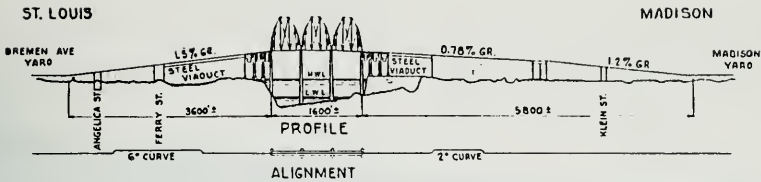
William J. Gilbert

Good morning ladies and gentlemen. On behalf of the railroads here in St. Louis, I would like to take this opportunity to welcome you all here. If you have the time to look around, we have a lot to see, including the Mississippi River bridges that we are discussing today.

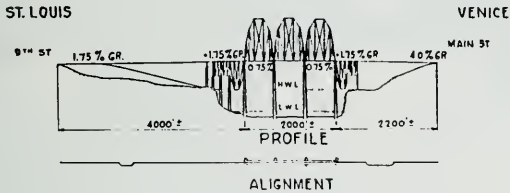
Eads Bridge

This presentation will not attempt to repeat all that has been written about Captain James Buchanan Eads and his now-famous Eads Bridge, but merely highlight the engineering innovations and perhaps whet the appetite for more information for those of you who are history buffs. The information presented is from various sources in our company files. James Eads was born in 1820 and at age 18 began a career working on the Mississippi River. At age 22 he invented a diving bell for salvage of sunken steam boats and earned a sizable fortune providing the salvage service. Performing this type of work taught him about the characteristics of the river bottom and its treacherous currents. During the Civil War, he built a fleet of iron-clad gunboats for use on the Mississippi River by the Union Navy. This introduced Captain Eads to important contacts in Washington that would prove valuable later on.

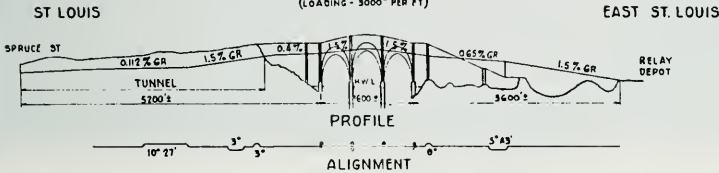
In 1867 James Eads, who had no formal engineering training and had never built a bridge before, began the challenge to bridge the Mississippi. Other proposals to span the river by Charles Ellet, Jr., in 1830 and John A. Roebling, of Brooklyn Bridge fame, in 1860, had been dropped. Political opponents representing river boat interests persuaded Congress to restrict any bridge at St. Louis to minimum span lengths of 500 feet and above water clear-



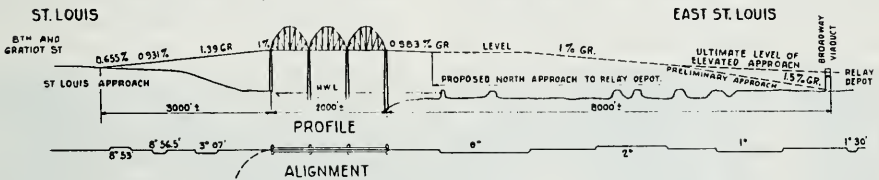
MERCHANTS BRIDGE
(LOADING COOPERS E 41)



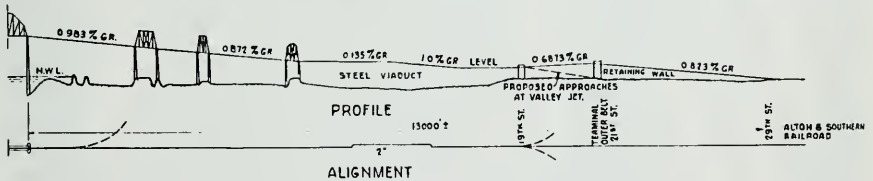
MCKINLEY BRIDGE
(LOADING - 3000' PER FT)



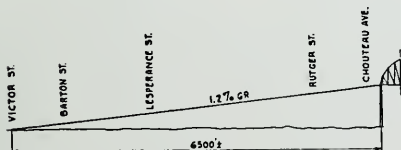
EADS BRIDGE
(LOADING - COOPERS E 36)



MUNICIPAL BRIDGE
AND PROPOSED APPROACH TO RELAY DEPOT
(LOADING COOPERS E 60)



PRESENT MUNICIPAL BRIDGE APPROACH TO 29TH. ST. (EAST ST. LOUIS)



PROPOSED SOUTH ST. LOUIS APPROACH

PROFILES AND ALIGNMENTS
OF THE
FOUR BRIDGES CROSSING MISSISSIPPI RIVER
AT ST. LOUIS

HORIZONTAL SCALES 0 800 1600 2400
VERTICAL SCALES 0 80 160 240

1921
PREPARED FOR ENGINEERS COMMITTEE INVESTIGATING
ST. LOUIS - EAST ST. LOUIS RAILROAD TERMINALS
C. E. SMITH & CO. CONSULTING ENGINEERS



Eads Bridge

ance of 50 feet. They were confident such requirements would doom the project. Public confidence in bridge engineering was low with one out of four bridges ending in collapse. Other engineers labeled the project as too difficult, impractical, and inordinately expensive.

If anyone could make this dream a reality, it would be James Eads. He hired, as associates, several outstanding designers, including Colonel Henry Flad, noted railroad construction engineer; Charles Pfeiffer, a mathematician; Theodore Cooper of Cooper's E-loading fame; and Washington University Professor William Chauvenet, whose theory of ribbed arch set forth the new principles that made this structure possible. The professor also invented a device for measuring the modulus of elasticity to allow computing of the steel stresses. Eads' knowledge of the river bottom made him believe many railroad bridge failures were due to scouring action; therefore, he insisted that the foundation be placed on bedrock. This feature has allowed the bridges to survive to this day through many floods, ice jams, and barge collisions.

Construction to bedrock created more problems to overcome, resulting in adopting the new French pneumatic caisson method of pier

sinking, requiring the invention of a sand pump and exposing the workmen to a new occupational hazard known as the bends. The east river pier was begun in April, 1869, and using up to 1,500 workmen, this new system sunk the pier to bedrock 96 feet below water, or, 136 feet below water surface, a feat never before attempted anywhere. An anchoring celebration was held on February 28, 1870. The other piers were then placed in about three-month time frames. These feats of engineering, using new and untried methods, were a tribute to the vision, courage, and daring of James Eads.

The contractor for the erection of the bridge structure was Keystone Bridge Company of Pittsburgh, whose vice president was Andrew Carnegie. Eads and Carnegie worked together to develop the steel required for this bridge. Previous bridges were constructed of wrought iron. Unheard-of specifications were demanded by Eads for calculations and testing for elastic limits and modulus of elasticity. Carnegie described Eads as an "original genius who must have everything done according to his own ideas without reasonable compromise." The steel produced at this time would only pass a 30,000 pounds per square inch test; therefore a chrome alloy steel was developed that passed a

60,000 pounds per square inch test. This chrome alloy steel has lasted into 1991 without rusting away.

Again, innovations were required for erection procedures. The erection methods were devised by Colonel Flad. This was the first large-scale use of the cantilever technique. No falsework was involved in the erection, the arches being upheld by an ingenious system of cables passing over wooden towers at each pier with hydraulic jacks to maintain uniform tension as temperature changed. Financial investors were becoming nervous and refused to advance further funds until an arch was closed in. Eads offered a \$30,000 bonus to Keystone Bridge Company if they could close all three arches by January 1, 1874. This was effective as the first arch was closed on September 17, 1873, and the other two by October 27, 1873.

On July 2, 1874, the completed bridge was tested by operating 14 coupled locomotives across the river. This test was an impressive site and was witnessed by thousands of St. Louisans. Careful measurements of deflections and stresses checked to the exact degree that was expected. Official dedication was July 4,

1874, with one of the greatest celebrations St. Louis has ever known, including a 15 mile long parade. In 1920, James Eads became the first engineer to be elected to the American Hall of Fame.

The length of the bridge is 1,627 feet with spans of 502 feet, 520 feet and 502 feet. The total weight is 13,135,500 pounds. The cost was \$6,536,729.99. Use of the railroad deck ceased in November 1974.

Merchants Bridge

Not much has been written about the Merchants Bridge. On April 4, 1886, those concerned about a bridge monopoly by the St. Louis Bridge Company, owner of the Eads Bridge, incorporated the St. Louis Merchants Bridge Company to build a competing bridge. The structure was designed by George Morison and constructed by the Union Bridge Company, including Keystone Bridge Company as a sub-contractor. Progress photos were taken and dated, giving a complete insight into the bridge construction.

Work began on the shore line on February 2, 1889. By May the first pier was above water



Merchants Bridge



MacArthur Bridge

line, using the same construction methods developed by James Eads. Pier construction continued simultaneously all across the river through the summer. Falsework was started in September and a traveling gantry crane installed by October 25, 1889. The first steel in the east truss was erected at 11:00 a.m. on November 9, 1889, and the entire 521 foot long truss span was completed by 11:15 a.m. on November 17, 1889. After completion of falsework for the second span on December 5, 1889, the steel work was begun with completion by December 11, 1889. The third truss span was begun on December 18, 1889, and completed on December 30, 1889.

Approach spans were erected by February, 1890. By February 10, 1890, track work was being installed. Progress photo No. 111, dated March 1, 1890, is labeled "The Finished Bridge." Work continued until final completion on June 21, 1890, at a cost of \$1,452,239.

Bridge construction techniques had advanced to building the Merchants Bridge in 13 months what had taken James Eads seven years to complete. Can we do as well today?

A bridge is a continuing evolution. In 1903 the floor system was rebuilt to carry heavier loads. In 1930 the floor system was again

rebuilt to carry even heavier loads. We are again looking at 125 ton heavier loads which can be handled. In 1988 we raised the cross bracing to increase overhead clearance for double-stack containers.

MacArthur Bridge

The MacArthur Bridge was conceived as the Municipal Bridge MacArthur Commission by the City of St. Louis on April 25, 1905. Construction began in 1909, but funding ran out in 1912 after only the three river spans were completed.

The design was for a double deck, with rail traffic on the bottom and highway traffic on top. After additional funding was secured, the roadway deck was completed on January 20, 1917, and operated toll-free until 1932 when tolls were initiated to finance depression relief programs; hence, the nickname, the "Free Bridge".

Finally, the railroad connections were made. On September 24, 1930, the East Approach and South Approach were completed, allowing train operation between the Alton and Southern and the Manufacturers Railway. A connection was added to Valley Junction in 1937. Both North

Approach and West Approach were constructed in 1939 with the first through train operated on January 15, 1940.

This bridge, with three river truss spans at 668 feet each, clears high water at 65 feet. With all the approach structures, this bridge is 4.5 miles long, making it the second longest steel railway bridge in the United States, second only to the Huey Long Bridge in New Orleans.

The St. Louis metropolitan area has begun construction of a light rail transit system known as Metro Link. This system will utilize the unused Eads Bridge rail deck and railroad tunnel under the downtown area. To get this ready-made access for transit and to save millions of dollars of construction costs, the City of St. Louis and the Terminal Railroad Association of St. Louis agreed to swap the Eads Bridge for the MacArthur Bridge effective August 31,

1989. This has been termed the largest real estate transaction in the history of Missouri.

The transfer of the MacArthur Bridge to the TRRA allowed for a long desired project to revise the track layout at Gratiot Street Interlocking and eliminate the 1,100 foot long bridge known as the Union Depot (U.D.) Connection, which had been built in 1894. This bridge had an approach grade of 2.6 percent and a reverse curve of 11 degrees 30 minutes not compatible with today's long, heavy trains. The new bypass on fill has a grade of 1.6 percent and curvature of 6 degrees 30 minutes.

The demolition of the U.D. bridge, although not difficult was accomplished by some innovative contractual arrangements. Mr. Bob McCann of Midwest Mobile Services will expand on this.

UNION DEPOT CONNECTING BRIDGE

Robert McCann

Midwest Mobile Cranes



Robert McCann

Thank you, Bill. Good morning ladies and gentlemen. In September, 1990, Mr. Gilbert and the Terminal Railroad were kind enough to allow a fledgling company called Midwest Mobile Cranes to bid on the Union Depot bridge dismantling project. To even allow a new company to bid a project of this scope requires a certain amount of open mindedness. After all, this was to be a highly visible project performed in downtown St. Louis. There were time restrictions involved regarding the completion of work and multiple landowners and leases involved. I want to publicly thank Mr. Gilbert and the other officers of the Terminal Railroad for allowing us that opportunity.

The UD bridge was constructed in 1906 to provide connections to Union Station which was, at that time, the largest passenger depot in the country. After serving the needs of the railroad for 84 years a change in track routing made the UD bridge obsolete. In order to open the adjacent area for future development it was decided to remove the bridge.

Since the structure was entirely within the confines of railroad property, did not cross

water or city-owned property, the actual access and dismantling of the bridge was very straight forward. What I feel is of more importance and interest is the "partnership contract" which developed between Midwest Mobile Cranes and the Terminal Railroad Association.

Traditionally a contractor would approach a project like this in one of several ways. The usual method is to submit a time and material or a fixed cost bid for the demolition work allowing the railroad to dispose of the scrap and recover whatever revenue is generated by sale of salvageable steel. This type of bid lends itself to over-estimating costs or dragging out the project to increase billing.

Let me expand on this a little. In submitting a time and material bid, there are two inherent problem areas. One is the temptation to inflate the cost per hour for both equipment and manpower. Also, of course, there exists the temptation to reduce, in subtle ways, the overall productivity of the job in order to increase billable hours. Frankly, in a time and material contract there is little, if any, incentive to reduce costs or increase productivity.

On a fixed bid basis you are taking the chance that the contractor guessed just right. If he under-estimates his costs he may not be willing or able to complete the project without additional compensation or he may be forced to cut corners which affect site safety and the overall outcome of the project.

If, on the other hand, all of your bidders over-estimated their costs and profit margins then you have simply paid too much to get the work done. Obviously we all hope that no contractor would succumb to these temptations but why take the risk.

Another traditional method of bidding this type of project is for the contractor to assume title to all salvageable material to help offset the cost of demolition. The temptation here is to first, underestimate the value and amount of salvageable material, and, second, to figure profits based on whatever the market will bear.

All of these methods tend to favor the contractor at the expense of the railroad. Being a relatively new company, I thought it appropriate that Midwest Mobile Cranes develop a new approach to this type of project.

First, in order to ascertain the exact amount of recoverable steel we solicited the railroad, two steel salvage companies, one steel repro-

cessing company and finally, we hired a bridge engineer to estimate the total weight of the steel involved.

Since we could not determine the weight of salvageable steel involved we decided to approach this contract differently. The removal and disposal of the concrete and granite supports as well as one approach ramp were beyond the capability of my equipment and had to be subcontracted. After soliciting bids for this work we arrived at \$35,000 as the cost of the concrete work.

At this point we approached the Terminal Railroad with what I felt was a true partnership arrangement. We proposed to jointly own the salvageable steel from the bridge, deduct the loss of subcontracted work and divide the excess income, if any, from the sale of the steel between the two companies according to a negotiated percentage. More simply put, all of the steel would be sold, the \$35,000 concrete cost deducted and the balance split between us.

Since MMC had to absorb the direct cost of dismantling the steel it was agreed that if there were any moneys in excess of the \$35,000 it would be split 60 percent to MMC and 40 percent to TRRA. The allocation of these percentages is really the key to this type of contract. It requires a very open discussion of the scope of work, the risks involved and any anticipated problem areas. This negotiation is critical to the outcome of the project. Had the project been less labor intensive or if it could have been performed in the summer with better weather conditions the percentages would have been different. On the other hand, if the bridge crossed water, city streets, or even been of a different construction style then, again, the revenue split might have changed.

This agreement relieved the railroads of any burden and would allow them to participate in any profits. We based our calculations on the minimum estimated weight of recoverable steel, 1,000 tons. We contracted the sale of the steel in advance for \$80 per net ton so on a worst-case-basis the breakdown would have been as shown on the slide. Believe me, it was a pleasure to send the Terminal Railroad a check for \$36,755.70 as their share in this venture.

I hope that I have made the point that there are always new ways of approaching difficult situations and further, that with a little trust and

honest negotiation it is possible to develop a contract which allows both parties to benefit.

Let me spend a little time discussing some of the specific problems that must be addressed when you are considering this type of project.

1. Gross versus net tons of salvageable steel

Make sure you are comparing apples with apples. A gross ton is 2,200 pounds. A net ton is 2,000 pounds. A ten percent difference which, when you are dealing with 1,500 tons can make a considerable impact on project costs.

2. Locking in a price for salvage steel

We really had to arm twist to get steel reclaimers to lock in a price for steel that would not be available for 90 to 120 days. But this is critical to the overall success of the project. During the UD bridge job the price of steel went up \$5 per ton 30 days after we had signed the contract but had dropped \$15 per ton by the time the steel was actually available.

3. Reclaimers can buy your steel in two ways. Prepared, which means cut into three to five foot lengths, or unprepared in 20 to 40 foot lengths. The availability of manpower and equipment to cut up the steel is the determining factor. In our case we opted to ship the steel unprepared because the labor to cut it up would have caused us to be trading dollars and we were able to negotiate having the processor transport the unprepared steel on their flatbeds at no charge.

In summary let me say that projects of this type should not put you in an adversarial position with your contractors. With the right attitude you and your contractor can truly become partners in sharing both the risks and rewards. Midwest Mobile Cranes has been dedicated to and successful at establishing this type of mutually beneficial contract. I hope that each of you will be able to enter into a partnership contract. I know that you'll be pleased with the results.

Thank you for your time and attention.
(Applause)

Mr. Saletnik: Bill and Bob, on behalf of both Associations I thank you very much for sharing a little bit about your hometown bridges with visitors and presenting such a unique and practical relationship. I would now like to turn the podium over to Keith Nordlund.

Mr. Nordlund: Thank you, Paul. The next special feature for this morning's session is the Impact of North American Free Trade Initiatives and will be presented by Richard Lande of Lande and Associates. Richard Lande will provide an insight to free trade and its impact on the transportation industry. He will address his comments on the interdependency of the current U.S.A./Canada agreement and the latest direction on the third country agreement. That third country, of course, is Mexico, although some people may think about the Province of Quebec. Maybe Richard, being from Montreal, may want to make a comment about Quebec and its own ambitions. Richard Lande has a private legal practice specializing in transportation law with offices in the United States as well as Canada and Hong Kong. He is associate professor in the Department of Management at Concordia University and assistant director of the Concordia Transportation Center. He received a degree in economics and political science from McGill University and a civil law degree from the University of Montreal. He is currently working on his Ph.D. thesis at the University of Bath, England, and is the author of several books on railway law, deregulation and the National Transport Policy of Canada. He has served as president and chairman of several transportation associations and is a sustaining member of the American Society of Transportation and Logistics. Please welcome Richard Lande. (Applause)

IMPACT OF NORTH AMERICAN FREE TRADE INITIATIVES

Richard Lande

Lande and Associates

Thank you very much, Keith, for giving me this opportunity to speak to you today on both the inter-relationship, tradewise, between Canada and the United States and Mexico. Keith is correct, I am from Quebec and if time permits I would like to give you a glimpse of what is transpiring in that province of ours. There will probably be a referendum this year on separating from Canada, so you should at least when you go home know that things are happening that will be of some interest to Canadian trade and the Canadian dollar in the next year.

Being from Quebec I'm what is known as an Anglephone. You probably don't know what that means. In Quebec we divide people up into three categories: you are either a Francophone, which means that your mother tongue is French; an Anglephone which means that your mother tongue is English; or for a person who came from another country and immigrated to Canada, they are called Alaphone. This could be quite amusing if it were not for the fact that Alaphones cannot send their children to English schools in Quebec. So depending upon which of the three categories you happen to fit into you can either send your children to schools of your choice or not. Anyway, I'm an Anglephone and so when I went to law school I wanted to familiarize myself with the French language even though the language at home was English because I knew that, as a lawyer, I would have to go to court and so forth. So I went to as many French movies as I could and I picked up some rather colloquial expressions, some of which I didn't entirely understand. One of the films that I saw involved a father who was telling his son to roll up the top of a convertible. He used a term whose meaning I didn't realize. He said, "It's raining. Please put the top of the convertible on." Unbeknownst to me, the word also means condom. So I went around with this false image that proved to be my failing at one of the interviews with a prestigious law firm. As luck would have it, during one summer I worked for a steel factory and we made the bodies of cars. We used to call the steel body blue steel because it was very

smooth and could be easily painted. So during an interview with a prestigious law firm, the steel experience was on my resume and the partner of the law firm looked at it and said to me in French, "I see that you have worked at a factory. What did you do there?" So I said in French, "Well, at that company we made steel condoms." (Laughter) I could see that he was visibly affected by that and he actually leaned over the desk and in a whisper repeated, in disbelief, what I had told him. I thought he wanted more information and I said to him, again in French, "Yes. We used to call it blue steel because it was so smooth." (Laughter) Anyway, as you can see, I subsequently had to go into practice for myself. (Laughter)

The subject that I would like to talk about today on a more serious note is the Canada/U.S. free trade agreement. I would like to give you enough detail so that you can go home understanding more of the relationship between the two countries than you do right now, but I don't want to get bogged down in details on terms that don't really mean much unless you happen to be a customs officer or interested in a particular technical aspect of the trade relationship.

Let me start off by saying that Canada and the United States are each other's largest trading partners so that even though Canada is ten times smaller than the United States, Canada, nonetheless represents the United States' largest trading partner. There was approximately \$200 billion of trade in 1989, between the two countries. If one were to look at imports versus exports you would be quite impressed that the numbers were almost equivalent. In other words, it's about \$100 billion of goods and services going from the United States to Canada and the equivalent going from Canada to the United States. Because Canada is so much smaller than the U.S. that \$100 billion constitutes a much larger percentage of our trade than it would yours. So that if one takes, for example, the provinces of Ontario and Quebec, which is central Canada, about 80 percent of their imports and exports derive from the United States. So that's how significant that

trade factor it. Now if you look at it from the U. S. perspective, about 20 percent of your trade is derived from Canada. So the first point that I want to make is that although trade with the United States is overwhelmingly important to Canada, trade with Canada is quite important to the United States to the tune of 20 percent. That happens to be more trade than with the European Economic Community or with Japan. So we are talking about a \$100 billion here.

The second point I would like to make is that there are, a lot of you know, southbound movements of say, potash from Saskatchewan and lumber from British Columbia, pulp and paper from Quebec, but what you probably don't appreciate, certainly I didn't until I saw these figures, is that there is oftentimes more northbound trade than southbound trade. In other words, one assumes if one looks at Canada as the term that was used in the eighteenth century by some of the British governors was that "Canadians were hewers of wood and drawers of water," indeed, a lot of our commodities are bulk. So it's true. We have a lot of grain and a lot of coal and certainly potash, lumber, and pulp and paper correspond to that, so there are a lot of non-manufactured products that are coming from Canada. But what is not appreciated is that there are an almost equal number of goods, sometimes the identical type of commodity, going from the United States to Canada. For example, there was about 80 million tons of goods going between the province of Ontario and the United States. If one were to do a commodity profile you would find that of the ten leading products, eight of them were the same. In other words that you could buy the same type of chemical from the U.S. going into Canada or from Canada going into the U.S. Automotive parts were going both ways.

So the importance of a free trade agreement and the significance of the same of the value of the Canadian dollar has a very direct impact on whether in the United States you buy products from other parts of the U.S., domestically, or rather you go to a cheaper source in Canada to get those same goods. That's the same as it is in Canada. You can buy the chemicals or the electronic or manufactured equipment or whatever from Canada or from the United States to Canada. There is a choice that is being made to the extent that you have barriers which make it more expensive or more difficult to have goods

from one country get efficiently and competitively into the other country then you will lose that market. There is nothing captive about it. That applies not just to the commodities themselves but it applies to transportation in general.

For example, if you take lumber products from British Columbia, they can go by rail through Canada and down into Buffalo and into Pennsylvania, the New England states or even the southeast. Those same commodities can, instead of going long haul by rail through Canada and then going down, they can go by truck or by rail, say Burlington Northern from British Columbia down into the U.S. through Chicago and the long haul will be in the United States. So on lumber products for example, and the thing works for wood pulp out of Alberta or potash, you can move it by Canadian carriers, given as we have just stated, there is \$200 million worth of trade going on. You can move the products through Canada or you can move the product long haul through the United States. The customers of those products will generally go to the less expensive transportation mode. I don't have to tell you that transportation is linked very closely with the cost of the goods, but to the extent that you have any type of customs barrier, price differential, freight rates differential, you'll see that there will be diversion in a very short space of time.

Let me just talk about this in another way. There was recently a postal strike in Canada. Because of this tremendous amount of trade that goes on between Canada and the United States a lot of mail and checks are sent from Canada to the U.S. So what a lot of companies did is they simply bought U. S. stamps and then they mailed all the U.S. destined or internationally destined mail at a post office box close to the border. As you all know, the border is very close to the major Canadian cities, Montreal, Toronto, Vancouver, Winnipeg and so forth. You can hop across the border if you find that the gas is less expensive. You can hop across the border if there is a no-tax situation. For example, in Canada, we have the goods and services tax, which is called the GST. In order to avoid the payment of that additional seven percent, a lot of Canadians go to factory outlets in New Hampshire and Washington, in order to save on the tax. So what I am describing here is something which an economist would term, "a continental economy". In other words, although

we have three nations, Canada, U.S., Mexico, in North America, the citizens, say of Canada, in terms of their selection of goods and services can choose either a Canadian service, in most instances, or a U.S. service. In other words, if you don't want to bank with the Royal Bank of Canada then you can bank with American Express, a U. S. bank or trust company. There is nothing to prevent the flow of a service, insurance, telecommunications, telephone. You can either use the Canadian or the American. That is the same way it is for the U.S. market as well. But if U.S. purchasers find that stamps in Canada are less expensive to send things to Europe, then they will buy Canadian stamps. So what we have seen since the free trade agreement has started at the beginning of 1988 between Canada and the United States is that a lot of Canadian companies, in order to avoid certain types of taxes, have put in distribution centers on the U. S. side of the border and that would theoretically enable them to perhaps pay the lesser labor costs within the United States, the lesser tax burden and also provide a kind of launching pad for a marketplace that is ten times larger than Canada's.

I would like to tell you a little bit about the free trade agreement so that you understand what the Canada/U.S. free trade agreement is. This is an agreement that was signed in 1987 between the two countries and what is being proposed for Mexico is something quite similar except it would involve the three countries rather than just two.

Free trade is kind of a misnomer in a certain sense. What free trade involves is not the same type of harmonization that is currently going on in Europe for 1992, where they have, for example, the transportation regulations of various European countries that are being equated, one with the other. They are being equalized. Instead of having your own regulations you have European standard regulations. That's called harmonization. The free trade agreement is not an agreement that focuses on harmonization. Rather, it focuses on something called national treatment. Now, national treatment is that in each country you treat the goods and services of the other country no less favorably than you treat your own. It doesn't mean that the goods and services have the same rules. It just means that you don't discriminate against the goods or the services of the other country.

You treat them no less favorably than you treat your own goods and services. Now, that's not harmonization.

The free trade agreement came into effect in 1988 and the first thing that it did was eliminate all tariffs, any dutiable goods between the two countries over a ten year period, in three stages. So for example, railway equipment was dutied as between 15 percent and 17-1/2 percent, depending on where the particular piece of equipment fits into the regulations that will disappear within the next few years. As of 1998 there will be no duty applicable on any goods or merchandise which is originating in either Canada or the United States. So that, in a nutshell, is why they call it free trade.

Now I have to tell you that about 70 percent of the goods between Canada and the United States were already duty-free before they signed the agreement. Indeed, about 80 percent of the goods between Mexico and Canada/U.S. are already duty-free. But that residual 20 or 30 percent is what is going to be eliminated. And that can be quite important. It can be very important if your commodity happens to fall within the dutiable goods. Aircraft equipment was duty-free before but electronics and textiles were in the residual portion.

There's another term that I have to talk about and that will be the last technical term. It's called rules of origin. You hear this all the time. The concept of rules of origin is that any goods that originate in the United States and are going to Canada or eventually to Mexico have to have at least 50 percent of its content being American. In other words, you cannot import something from Japan and put in a small component which happens to be American and then trade it and pretend that the whole thing is American.

That of course works in the reverse. There has to be at least 50 percent of the content of the goods, so if we're talking about a railway combustion engine that comes from Korea, there are two or three things that have to happen for the free trade tariff elimination to work. First, there has to be what they call substantial transformation. They have to make sure that the engine is considered as being a necessary part of the whole vehicle. Second, 50 percent of the railway engine has to be American originating in terms of materials and there is a third test that is the value test. The value test roughly would say that at least 50 percent of the value

has to be American. Those value percentages are going to change as the free trade agreement nears its completion.

Let's look at the Mexican component of this. The Canadian American free trade agreement was signed in 1987 and, as I just told you, it eliminates all duties over a ten year period provided that the goods have at least 50 percent of national content. This, of course, applies to automotive parts as well, which was already subject to something that I'm sure you have already heard of, called the auto pact between Canada and the United States.

Originally, when they were talking about the free trade agreement between Canada and the United States, there was supposed to be a transportation annex but it was felt that this would jeopardize some of the interest groups in the United States to put free trade onto, for example, the coastal marine industry. In the United States, you have a Jones Act. The Jones Act requires that any type of coastal movement be delivered by a U.S. vessel. So companies in Canada, like Canada Steamship Lines wanted this to be subject to the free trade agreement. Instead of having a rule that said that all domestic U. S. deliveries by water should be by a U. S. bottom, as it's called, they wanted to have Canada or U. S. bottom. In other words, the principle of national treatment is that you treat the other country no less favorably than you are treating yourself. But the U. S. marine industry thought differently and as a consequence, there was no transportation annex to the free trade agreement. This was considered quite disappointing to, for example, the Canadian maritime industry.

Now, the Mexico/Canada/U.S. agreement is being worked on. Next month they are all meeting in Mexico. Mexico's president has predicted that the tripartite arrangement would be completed by May and that will mean that you will have the same type of national treatment concept applied to goods and services between the three countries if it is signed.

So now you understand the free trade agreement. It also liberalizes investment opportunities between the two countries. The argument was that it was going to take away a lot of Canadian jobs because companies in Canada would have their corporate headquarters in the United States if they had a choice. This is probably going to be the argument that you will see

as the Mexican/U.S./Canada arrangements come closer to being signed. There will be some people who will say that you can fabricate auto parts much more cheaply in Mexico than you can in the United States. Why are we giving away U.S. jobs to Mexican employees when there is so much unemployment at home? So the type of argument that is used against a free trade agreement is that you don't want to lose the protection of your own industries. I'm not sure that the free trade agreement between the three countries will be signed because it's always difficult to take a risk. A lot of people in Canada feel that since the free trade agreement has been signed between Canada and the United States a lot of companies have left Canada. Newspaper articles sort of give a documented list of companies that have simply closed down their Canadian subsidiary or simply moved across the border, as I mentioned earlier. It's very difficult to know for sure what was specifically the cause of the move. But there are, nonetheless, several thousand jobs that have left Canada since the free trade agreement was signed. Whether they left Canada because of the free trade agreement or not is something that I don't know.

So, in summary then, we see that there is a continental economy where you can buy your stamps or your gas or your bank services or hire your lawyer or your insurance company either from one country or the other. If the Canada/Mexico/U.S. free trade agreement succeeds then you could hire those services from any of the three but that is quite distinct from what is going on in Europe where there will be harmonization as of next year.

I would like to end, if I may, with a little glimpse of my home province of Quebec. As I mentioned to you at the outset there will be a referendum on whether or not Quebec separates from the rest of Canada by the end of 1992. So there are about fourteen months left and it's obviously a very emotional debate because there are two political parties within the province and both of them are in favor of separation unless the rest of Canada, we call that TROC, gives Quebec a constitutional amending formula. In the event that Quebec becomes a country, this could be a federation similar to Switzerland. It might mean, for example, that you would have one currency. It might mean that you would preserve the same army, but

that of course, assumes that the rest of Canada would be able to survive without a portion in the middle. So you would have kind of a western part, Ontario, and then you would have Quebec and then you would have the Atlantic provinces so it would be, logistically, a little bit difficult to have a country with the center partially removed.

Be that as it may, it would obviously affect the value of the Canadian dollar. It would affect Crown corporations. For example, Keith works for Canadian National. Just to give you an idea of the problems, who would own it? Canadian National is owned by the government of Canada. If Canada separates, then one third of Keith should belong to Quebec and two thirds of Keith should belong to TROC. That, of course, assumes that this can be divided. If, for example, in terms of rail it might be easier, because the rail infrastructure within Quebec can theoretically become Quebec property. But what happens to an airport? A seaport? Or what happens to the national debt? How do we divide up the debt? So it really would be a mess. I'm not in favor of Quebec separating because I consider myself to be a Canadian first, but it's a democratic process and anything can happen. There is not likely to be any military intervention because that has not been part of the Canadian culture as it has been in other countries. We're not going to see an Ireland or a Croatia situation develop. Whatever happens, I would suspect, although there may be rather high emotions flowing, will not involve an army coming in and preserving the peace.

Anyway, you should look in your newspapers because I would suspect that in the next year there will be quite a few articles on this referendum and although I probably shouldn't be saying this, you should probably not keep a whole lot of Canadian dollars in your special account. (Laughter) The value of the Canadian dollar is being almost 88 cents now; it's increased by over 20 percent since 1986. If you speak to a lot of Canadian manufacturers in the steel industry and so forth they will tell you that the reason we are undergoing a recession in Canada is because the value of that dollar is so very high and is, therefore, preventing sales to our largest trading partner, the United States. So, in a way, it may be like serendipity, you may have a Quebec referendum where the Canadian dollar goes down and then you'll

have resurgence of the Canadian economy. Thank you very much for having given me the opportunity to be with you today. (Applause)

Mr. Nordlund: We have a few minutes if anyone would like to ask Mr. Lande a question.

Member: What percentage of the gross national product of Canada is produced within Quebec?

Mr. Lande: Approximately one third. The markets for Quebec are generally the New England states, notably New Jersey and New York. I would also say you have pulp and paper going to the state of Maine. Whereas Ontario's markets would be Michigan and Ohio and to a certain extent, the midwest. Generally when you follow the trade patterns you see that you can almost do some straight line downward to the major areas of the U. S. where the trading goes between Montreal and New York, Toronto and Buffalo, Vancouver and California. Although a lot of people assume that the southeast or Florida is quite important to the Canadian economy, that may not necessarily be the case.

In terms of population it's also about seven million out of a population of 24 million. So we're talking about a substantial part of the country.

Member: On that free trade agreement how would that effect labor crossing the border?

Mr. Lande: I'll just read you something I was looking at here. "There are temporary entry provisions of the free trade agreement which are designed to make it easier for persons of each country to enter the other. Labor certification requirements are removed for persons who fall into the appropriate categories which are outlined in the free trade agreement." I'm happy to say that lawyers can go freely between one country and the other. I'm sure that makes you happy too. (Laughter) Theoretically, these provisions should be beneficial to transportation companies which are sending various employees to the United States on a temporary basis. As to how this is working out in practice remains to be seen. Certainly, the obvious beneficiaries of a temporary entry provision have been immigration lawyers. The temporary entry provision of the free trade agreement applies only to citizens of Canada and the United States. So, if for example, a truck driver is a landed immigrant, then the provisions do not apply. So what I am saying is that the free trade agreement does not entitle, does not exempt the

ordinary immigration procedures from going on. But if it's a temporary entry status then again, you have to remember national treatment applies. You have to treat the applicant no less favorably than you treat your own.

Member: I'm with Canadian Pacific and I live in TROC. (Laughter) I was just wondering if you see any evidence so far of companies starting to reposition themselves as a safety gap in recognition of Quebec separating? I'm thinking of the CP, for example, going with the Soo and Delaware and Hudson.

Mr. Lande: Well, I'm not sure what prompted your company to buy out the minority shareholders of the Soo Line or to recently get the D&H, whether that was a Quebec factor decision or not. There is a lot of trade that goes on between the port of New York/New Jersey and eastern Canada. I was describing to you before the way you can have routing diversions; that same theory would apply to marine. For example instead of ACL going into the port of Halifax, Nova Scotia, they could just as well go through the port of Elizabethtown in New Jersey, and then move the goods up into Canada that way. I haven't seen a lot of repositioning. It seems that most Canadians, because we are somewhat used to this type of debate going on, seem to feel that this is just another little crises. We got over some of the other constitutional crises in the past and we'll get over this one. But one is different. You may recall that about 20 years ago there was a referendum on Quebec independence and the vote was 60 percent of the residents of Quebec in favor of Canada being their country. Now times have changed; in 20 years that feeling may not be there. It was 60 to 40 last time and you don't need much for that to move. That's the terrifying thing about democracy. You can actually vote yourself out of a country. There are enough people who feel strongly enough that they want to have their own passport and their own sovereign entity. There will obviously be some economic fallout from that decision and I guess the only major difference that I can see is that there are no strong Canadian leaders today who can take on the role of being the pro-Canada force. In other words, Brian Mulroney who is our current prime minister, is hitting the Guinness Book of Records for low popularity. President Bush has a popularity rating of somewhere between 60 and 70 percent; our poor prime minister is between 15 and 20 percent and wavering. We

have a new western party called the Reform Party which is led by Preston Manning and it is likely, if elections were to take place this year, that they would win a large number of federal seats in Saskatchewan, Alberta, British Columbia and Manitoba. Similarly, there is another party in Quebec, called the Bloc. That is pro-sovereign. So we have a lot of dynamics in Canada right now that are jeopardizing Canadian unity and very few people who have good credibility with the population who are in favor of one country.

Member: If Quebec should successfully succeed from the rest of Canada do you see an evacuation of the business out of Quebec to TROC? Is that a possibility?

Mr. Lande: As I mentioned before, Quebec has a lot of business with the United States. It is perhaps arguable that they do more business with the U.S. than they do with TROC so those companies who are there could say that they do not need the Ontario markets to survive. What they need is the American market. It depends on which business they are in. Therefore, I don't really see any type of exodus that some people fear. When they had the first referendum in the 1970s there were a lot of Anglaphones who left. I should have bought my house at that time because houses were going for a good value in 1976 in Quebec as all the Anglaphones who decided they were uncomfortable in a possibly French country, with no guarantees of constitutional minority rights, left. The ones who stayed would probably continue to stay because they have managed to put up with these silly language laws and so forth. I don't see an exodus of business but I do see a belt-tightening depending of course, on if there is one Canadian dollar. Assuming that TROC does not agree to having a common currency because TROC gets angry and says if you're dividing things up then keep your own currency. We have been talking about this. What would the currency be called? What do you think of Laurentian dollar? Quebec franc? It is estimated that a currency which would only be for the province of Quebec would be 30 cents U.S. So that, of course, would have a terrifying impact on people with assets and corporations with assets. It could actually be favorable in terms of market for export because the currency would be so low you could sell a lot of Quebec products.

I have enjoyed being here. Thank you very much. (Applause)

Mr. Nordlund: Thank you, Richard. You certainly got my attention when I realized that, from a personal point of view, one-third, two-thirds split. You've done us well this morning.

We appreciate your time and thank you for

sharing with us your views of the free trade and Quebec.

This ends our joint session and following a short recess we'll reconvene at 10:45 right here.

Recess

TUESDAY MORNING SESSION

September 24, 1991 – 10:45 a.m.

President Horney: Please be seated. The second session of our 96th conference is in session. At this time I will turn the program over to Doug DeBerg, sponsor of this morning's first special subject presentation.

Mr. DeBerg: Thank you, John. It's my pleasure at this time to introduce Dale Bartholomew. Dale was given the assignment of chairman of special subject No. 4 which deals with locomotive servicing facilities. After Dale completed his civil and structural engineering degrees he began working for the Great Northern Railway in 1968 as a design engineer. Eighteen years later after holding various positions with the Great Northern and Burlington

Northern, from planning engineer to principal structural engineer, he became senior project manager for railroad facilities engineering with Sverdrup Corporation in Seattle, Washington. Dale is a licensed, professional engineer in five states and has designed railroad facilities from Alabama to British Columbia and Chicago to San Diego. In keeping with the theme of this celebration of the 100th anniversary of the B&B Association, Dale and his committee have prepared a very thorough and interesting report that I think you will find interesting as well as timely. With that I would like to introduce Dale Bartholomew.

SPECIAL SUBJECT NO. 4

Locomotive Servicing Facilities

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M. L. Bradley, Proj.Engr., Conrail, Columbus OH
M. McMaster, Constr.Engr., Conrail, Dearborn MI
W. C. Sturm, Sr.Proj.Engr.Bldgs., EJ&E, Joliet IL
P. E. Sargent, UP, Omaha NE
G. W. McDonald, Sr.RR Cnstlnt., Omaha NE

Introduction

Locomotive servicing involves what is probably the most complex assortment of facilities found on railroad property. We can only take a broad stroke review of the multitude of services provided over the last 100 years and a brief look at the assortment of highly specialized skills required of B&B personnel who construct and maintain these locomotive servicing facilities.

Some aspects of locomotive servicing have

not changed since our Association's founding in 1891. We still load fuel and sand, replace brake shoes and do wheel work. But many functions have seen dramatic change. The number of fluids requiring specialized handling equipment and the regulations governing their handling have both greatly increased. Gone are the days of the fireman manually lubricating his locomotive. We now must construct and maintain specialized dispensing systems for: alcohol and other fuel additives, kerosene,

crankcase oil, journal lubricant, compressor oil, traction motor oil, brake gear and other lubricants, waste oil, potable water, waste water, radiator water or antifreeze, treated water, compressed air, sewage from locomotive cab holding tanks, detergents for locomotive washing facilities, centralized vacuum for cab cleaning, solvents, etc.

In addition, the complexity of locomotive servicing has increased due to automation. In 1891 most existing facilities required manual operations. Today, B&B personnel must know how to maintain a plethora of sophisticated monitoring and metering devices, computerized control and inventory systems, wire and fiber optic circuits and precision machinery of diverse types.

With the increased sophistication and the reduction in personnel that automation is thought to allow, are we providing an opportunity to validate Murphy's Law - "Anything that can go wrong will go wrong?" And, shouldn't we remember O'Toole's Corollary - "Murphy was an optimist?"

There have been problems. Utility vault fires demonstrated the inability of plastic conduit to protect control system wiring and prevent facility shutdowns. Buried fuel lines spring leaks also causing shutdowns and possible lawsuits. Environmental concerns are reaching formidable proportions. Yet many facilities are performing well. Safety has been improved. Our B&B personnel are using creative techniques for maintenance and constructions. They must be given credit for the fantastic job performed.

We will touch on some of the good and not-so-good designs or techniques observed by our committee. While many different functions must be accommodated at any one servicing facility, to effectively review the last 100 years and specifically address current practices, distinct functional aspects of locomotive servicing will be separately addressed.

Fueling Facilities

Historical Perspective

As the type of fuel changed over the years, a significant change in fueling facilities also occurred. Prior to 1891 and continuing until about 1910, wood burning locomotives were common. Manual loading from simple wood

piles or sheds was prevalent. The Association's 1891 Proceedings contained a report on coaling stations which illustrated a combination dock type facility. The roofed enclosure had bays for both wood and coal storage. All operations were manual. Wood and coal were stored in piles on the elevated dock floor. Manually loaded hoppers were pushed on transverse rails to dock edge for discharge into the locomotive tender.

Though used from the earliest days of railroading, from about 1910 into the 1950s, coal was king. Coaling facilities ranged from the simple to the monumental. Many methods were used to elevate coal above the locomotive for storage and discharge into the tender. Timber construction was common for early designs. Steel or concrete construction was prevalent after about 1910.

The committee provided illustrations of several types of vintage coaling facilities. One simple branch line coal dock, which remained operational until the mid 1950s, consisted of a raised platform, manually filled steel buckets and a timber derrick to swing the buckets over a locomotive's tender. The 1891 Coaling Station Report also presented a diagram of a steel and timber coaling tower which utilized a bucket conveyor to elevate coal and sand from unloading pits to flat-bottomed storage binds over the tracks. The maintenance of mechanized systems has always been a B&B concern.

Timber coal chutes were constructed on many railroads in the early 1900s. Hopper cars were pushed or winched up high trestles to unload by gravity into elevated storage pockets. The coal was then discharged, again by gravity, into a locomotive's tender. Timber coaling towers were also common. Towers typically utilized large cable-hoisted bucket elevators to raise coal to over-the-track bins.

Concrete coaling towers frequently had similar functional design as timber towers. Separate bins were sometimes provided for storage of passenger and freight coal and for sand. In other instances separate facilities were used. Steel towers could have similar design or might appear like an elevated tank. And yes, main line fueling facilities are not new.

Fuel oil was prominently used on some railroads from about the early 1920s also until the effective end of steamers in the late 1950s. One particularly impressive 120 foot diameter steel

rimmed storage tank was constructed in 1905. Fuel oil tank cars were unloaded into a timber flume between the rails on a slightly inclined trestle. A transverse timber flume conveyed the oil by gravity through the tank's timber roof. Tank discharge required pumping. Heating coils were provided at the inlet and outlet of all sizes and types of tanks to assure easy flow in all weather conditions.

From the late 1940s through the 1950s conversion to diesel fuel systematically occurred. Early diesel locomotive servicing was an adjunct to steam engine servicing. In the 1950s, facilities dedicated to diesel fueling began to be constructed. Some vintage diesel fueling stations are still in use.

Today

Most locomotive servicing facilities are tailor-made for fueling diesels. Two general types of fueling facilities are common: main line facilities, where complete through trains stop momentarily on main tracks; and terminal facilities, where locomotives are uncoupled to receive a higher level of service and cleaning, and are stored pending their next assignment.

While main line fueling is not new, the number of main line diesel fueling stations has increased. Some main line facilities only provide fuel. Others also provide sand. Some provide water and lubricants. Construction of main line facilities can pose unique problems. Care must be taken while working close to operating tracks. Train movements generally cannot be interrupted. Often staged construction and temporary detour tracks must be employed. A new side track sometimes can be built first and temporarily used for the main track.

Terminal locomotive fueling facilities are found in a wide variety of arrangements and sizes. Most provide sand and other services. Many are adjacent to heavy maintenance shops. Service crews prefer indoor facilities. Outdoor facilities are common, but slippery surfaces are a complaint. Patterned steel deck plate does not seem to be a solution.

Tracing the typical route of diesel fuel from its source (tank car unloading station), through all the required apparatus: pumps, storage tanks, filters, pipelines, monitoring and other specialized devices, to the locomotive fill point reveals two major deviations from steam era facilities. One, of course, is the complexity of newer systems. The other is the lost concept of

keeping facilities compact. Both increase maintenance concerns and environmental risks. Remember Murphy? There is a related rule: "Anything that's been put together will fall apart sooner or later." Let's look at each step of the route.

Loading/Unloading Stations

Some fueling facilities are supplied directly from interstate pipelines. Frequently these facilities load tank cars for shipment to other locations. A specialized loading column may be used for this operation. Some facilities perform a dual load/unload function giving the railroad a lowest cost supply option. Most facilities receive fuel via a tank car unload operation.

Storage

Fuel storage tanks can vary from second hand tank cars to large million-or-more gallon tanks. Large tanks require specialized construction techniques. Some railroads prefer massive solid foundations. Others use a concrete ring-wall with compacted gravel interior. Steel tank construction is typical.

Pumping

Pump stations are generally located near fuel storage tanks. Sometimes separate pump stations are provided for unloading and distribution. Fuel filters and flow meters typically are included as part of a pumping complex. Some pump stations have storage tanks and injection apparatus for adding alcohol or other additives to the fuel. Many of the specialized control systems are located in the pump house as indicated by the maze of conduits required under a typical floor slab. A detail of a skid frame-mounted portable fuel pump station, including filters and meter, was contributed by one committee member.

Distribution Piping

Piping used to be considered the most trouble-free part of a fueling facility. Steam era compactness did not seem important. Many terminal fueling facilities are fairly compact, but long lengths of piping and control lines frequently have to pass under many yard tracks or from one end of a yard to the other to reach a main line fueling facility. Some terminal facilities are also spread all over the property.

One example facility has fuel unloading tracks located at the far end of a peripheral yard on the opposite side of a river from the service facility. Fuel is pumped a few hundred feet under several tracks to storage tanks. From

there, separate pumps and piping carry the fuel several hundred feet underground to a 200-foot long river crossing mounted on a bridge, then underground a couple thousand feet through another yard to an old fuel handling complex. From there it is again pumped several hundred feet under numerous yard tracks to the fuel service facility. With the frequent leak testing now required, such distribution can be impractical.

Widely distributed systems sometimes cannot be avoided. One railroad found advantage in installing a 42-inch concrete pipe arch utility duct under a multiple track yard. Fuel line and control cables were easily installed and there is room for inspection and additional lines. The concrete pipe does leak however. Infiltrating water is carried to the nearest manhole where it is pumped to the waste water treatment plant to remove possible oil contaminants. Split casing pipes have also been effective to encase existing fuel lines passing under new tracks.

Service Platform Piping

Direct burial of piping under service platforms is sometimes economical. Placement of concrete slab joints is recommended to simplify inevitable reexcavation. Many railroads prefer pipe ducts under the full platform length. Maintenance and inspection is simplified. Some railroads use elevated piping along the service platform. Access and inspection are even simpler, but special corrosion and freeze protection may be required.

Fueling Crane

Some fueling facilities utilize a hose to transport fuel from fixed control valving to the locomotive. Many utilize fuel cranes. Most fuel stations have metering and flow control valving built in. Virtually all new facilities have devices to prevent or capture fuel spills.

Control systems

The control of fueling is critical for several reasons: to prevent waste, environmental contamination, excess wear, etc. Railroads utilize a variety of means to improve control, from informative posters to automation. Most facilities have equipment to monitor and regulate fuel flow from the unload station to the locomotive. Some systems are very sophisticated.

Burlington Northern Railroad is using an extensively computerized system. Tank car numbers are keyed into special data entry panels at each unload station. The amount of fuel unloaded is compared to loading records to

monitor loss in transit. Fuel amounts pumped into storage tanks and throughout the system are monitored to check for theft or leaks. Individual locomotive numbers are entered at data entry panels at the fueling station. Amounts of fuel loaded into each locomotive are compared to historical records to measure fuel efficiency and to warn of possible operating problems.

Economic benefits of the computerized control system include:

- Accurate fuel inventory records
- Real time inventory and equipment status
- Electronic receipts, invoice verification and payment
- Improved leak detection
- Operator accountability
- Reduced environmental cleanup costs
- Improved system security
- Locomotive mechanical information
- Locomotive fuel consumption data
- Automatic system control
- Accident and vandalism prevention
- Monitors miscellaneous fuels uses

Maintenance

With the complexity of many new fueling facilities, extraordinary maintenance procedures are required. Placement of meters and control and monitoring equipment above grade simplifies access. Installation of a dedicated telephone system between control panels at widely spaced unload station vaults, pump houses and fueling platform vaults will greatly aid communication and speed adjustments when personnel are required at each location to view equipment operation or perform circuit testing. To assure that B&B personnel have appropriate maintenance data available, one railroad specifies that eight copies of all As-Built Drawings and Maintenance and Installation Manuals be provided by contractors.

Sanding Facilities

Historical Perspective

Facilities for loading traction sand have functionally changed little over the last 100 years. Wet sand processing by railroads is rare today, however. Committee members made a number of historical sanding facility illustrations available. One showed elaborate 1918 details of sand screening and drying equipment installed in a concrete coaling tower. Drying was by heated compressed air. Wet sand was elevated

to a 75 ton bin using the coal cablelift bucket. After screening and drying, sand was then collected in a 20-ton bin for discharge into locomotives.

Simple outdoor timber wet sand bins requiring manual handling were built over 100 years ago and as recently as 1945. Various types of steel sand towers were constructed in the early 1900s. A 1909 double tower is still in use. One steel sand tank with air lift was built in 1945. The oldest pneumatic lift sand drum detail provided is dated 1952. An early "diesel sander" is dated 1963. Many vintage pneumatic sand towers are still in use.

Current Systems

Several different types of sanding systems are popular today. Each has advantages and supporters. Sanding should be performed in conjunction with fueling to avoid respotting locomotives. Most sand delivery systems use gravity or pneumatic transport at some point in the process. Mechanical conveyors and elevators are occasionally used. Most new systems are highly automated. Dry sand is delivered in sealed trucks or covered hoppers. To illustrate typical operations, a brief outline of three common systems is presented.

Gantry Crane Delivery

Gantry crane sand delivery provides great locomotive spotting flexibility. Sand is brought to the locomotive. Indoor or outdoor gantry crane sanding are equally common. The first process step is delivery of dry sand. Pneumatic or mechanical conveyor transport to a single storage tower at one end of the servicing facility is typical. Steel storage towers are common. Some facilities use concrete "silos." Gravity feed is typically used to fill the gantry mounted sand hopper and to discharge sand into the locomotives. The sanding gantry crane operator rides in a basket below the crane on some systems and lowers himself with the filling nozzles to the top of the locomotive.

Multiple Sand Towers

Multiple sand towers are usually evenly spaced along a fueling platform so that sand hoses can easily reach each locomotive. Dry sand typically is delivered in covered hopper cars which also serve as primary storage. Sand is discharged by gravity directly into the pneumatic transported tank under the unload track. Sand is then pneumatically transported under the service platform through sand pipes to sec-

ondary storage tanks at each tower. Pneumatic systems are highly automated, use specialized piping such as ceramic elbows, and have numerous control sensors. The required maintenance specialization is obvious.

Sand is gravity-loaded into locomotives through counter balanced swing booms and hoses. These booms have been known to provide a hard example of the importance of proper maintenance and preventing moisture entry into the sand. Boom counterweights are set to include the weight of sand inside the boom and hose. If moisture causes a plug at the sand tower tank exit, sand in the boom and hose will still flow into the locomotive and a rapid change in balance will occur. The first time this happened at one new facility the boom snapped up out of the unsuspecting operator's hand, causing the hose nozzle to knock out several teeth. This operator may consider Murphy an optimist.

Single Sand Tower

Though pneumatically operated, single sand tower systems with large slightly elevated primary storage bins operate differently than multiple sand tower systems. Dry sand, frequently delivered by truck, is pneumatically pumped into the large bin. Sand flows by gravity directly into transporter tanks at the tower base and then is pneumatically transported under high pressure (120 psi) to low level secondary storage drums evenly spaced along the locomotive servicing platform. Since pits are not required, sand piping is frequently elevated or placed in direct burial trenches. Two 45 degree Ys can be used as elbows, rather than ceramic ells, forcing turning abrasion against sand trapped in the stub ends. From the drums, sand is pneumatically pumped at low pressure (35 psi) through fill hoses to the locomotive. This system also can be highly automated and provides a more orderly appearance.

Water Handling Facilities

Boiler water service was a frequent large quantity requirement during the steam era. By 1891 elaborate water collection, storage and loading facilities were already established. Wells were a common source of water. Windmills sometimes performed pumping chores in remote locations. Standard pumphouse designs were common by 1944. Other water sources included lakes, river diversion and springs.

Lake or river water was occasionally transported many miles in canals, flumes or pipelines to near track surface reservoirs. Water was transported by tank car over 100 miles to some desert watering stations. Elevated tanks were commonly used for trackside storage. Timber tanks existed from the earliest days of railroading into the 1950s. Steel tanks became common after the early 1900s and some are still in use. Early standard water tank scaffold details confirm that water facility maintenance has long been a B&B crew task.

Locomotive filling was usually by water spouts attached directly to the tank structure. Water columns or standpipes were used with multiple track facilities. The Association's 1891 Proceedings contained a short report on water columns which outlined valving and freeze protection requirements and the need for columns to easily swing clear of the track.

Currently water demand is greatly diminished. Although some steam era wells are still in use, public water supply is now the most common. Specialized water treatment frequently is required. Providing handy water hose connection stands or hose reels on the locomotive servicing platform is a preferred practice. Outdoor hose reels are enclosed, insulated and sometimes heated for freeze protection.

Today, the greatest water usage is probably for diesel locomotive washing. Newer facilities are usually complex due to automation, specialized detergent or solvent dispensing systems, and water conservation systems.

Miscellaneous Services

The clutter of equipment on a servicing facility platform is an indication that a number of other specialized services are performed. The key concept for miscellaneous services is "keeping it handy." We will review some historical procedures and new ways of keeping things handy through a brief look at facilities used for some specific special services.

Inspection

Inspection facilities have been a part of locomotive servicing from the earliest days of railroading. Nearly every track in many roundhouses had inspection pits. In the early 1940s, outdoor diesel locomotive inspection pits were being added to existing facilities. Today, old roundhouse inspection pits, once considered obsolete, are being refurbished for efficient

continued use. Timber rail supports are being replaced with new concrete pit walls, floor slabs and direct rail fixation. Add new lighting and other general refurbishment and an elderly roundhouse can become an efficient modern inspection and maintenance facility.

When a 1960s single track indoor inspection and service facility was replaced with a larger multi-track outdoor facility, crews were reluctant to move. This occurred more for locomotive access inconvenience than for lack of shelter. The new facility does not have mezzanines and has only one short inspection pit on a separate track. This requires multiple locomotive respotting. Many say every track in a locomotive servicing facility should have full length inspection pits. Reduced safety with open pits is a tradeoff, however.

Facilities with elevated tracks and mezzanines provide greater convenience and safety. Details supplied by a committee member for one new inspection building illustrates many of the advantages and design considerations. A unique feature of this example is that due to a very restrictive site, elevated tracks at both ends are curved. This dictated a closer spacing and special reinforcement of rail support pedestals.

The example facility utilizes a full length combination elevated track and inspection pit. Pit access is limited so transverse pits are provided at frequent intervals. These locations also require additional pedestal reinforcement. Pedestal and pedestal foundation strength is an important design consideration for elevated track. All elements must be substantial and durable, yet access restrictions should be minimized. Deteriorated pedestal base supports have proven difficult to repair. But the extreme hazard of loose pedestals and spreading rails must be avoided. Most current designs use only the rails to carry wheel loads between closely spaced pedestals. Direct rail fixation to pedestal tops is now common.

High pedestal elevated track with flat lower level floor slabs throughout the servicing area provides the ultimate in duck-under anywhere accessibility. One submitted facility provided all-encompassing inspection capability by including overhead locomotive roof inspection catwalks.

Mezzanines

Nearly all locomotive service facilities with elevated tracks also have mezzanines to provide easy access to the locomotive deck and cab.

Many are completely enclosed indoor facilities. Currently full enclosures tend to have remotely operated or automatic end doors. Some prefer partially enclosed facilities with end and side openings to allow fumes to escape. Service crews have wondered why mezzanines are not more commonly provided with outdoor facilities even if there are no elevated tracks. The added safety and easy access seems most important for facilities subjected to inclement weather.

Gradual and wide, forklift compatible access ramps between main floor and inspection and mezzanine floor levels are essential to keep it handy. Forklift capacity movable bridges spanning between mezzanine decks of multiple track facilities provide a nice refinement. A hydraulically operated bascule type has worked well. Handrailing along open mezzanine sides are essential for safety, but should fold down out of the way or be removable by one man when locomotive access is desired.

Air and Lubricant Distribution

Compressed air production and storage entails a special assortment of highly automated equipment. Unique oils and greases for crankcase, journal, compressor, traction motor, brake gear and other equipment lubrication require special, increasingly complex, unloading and storage facilities. Platform delivery of air and lubricants to locomotives is usually accomplished through flexible hoses. Quick connect hose stations can be frequently spaced along a platform or under a mezzanine deck. Stands, which provide forklift protection, work well on mezzanines and may include AC power and other fluids. Hose reels, regularly spaced along platforms or mezzanines, are the current keep-it-handy favorite. Reels can also be provided at floor level under elevated tracks.

Brake Gear Service

While not involving highly automated systems, brake gear maintenance is an important part of locomotive servicing. Strategically located brake-shoe storage racks are a simple accommodation. The advantages of easy access provided by elevated tracks, however, cannot be overlooked.

Ash Removal (And Other-Environmental Facilities)

Historical Practice

During the entire steam era, ash removal was a major locomotive service function. The Asso-

ciation's 1891 Coaling Station Report depicted a facility with a bucket conveyor system for elevating ash from the locomotive discharge pit to over-the-track hoppers. Ash was then gravity dumped into rail cars for transport to a disposal area. Other examples depicted a multiple track gantry crane and clamshell bucket system built in 1910 and a 1938 cable operated bucket transporter. Both loaded cars directly from under track cinder pits. Dust control apparently was not a concern.

Modern Grit Removal

A drawing of a screw auger lift system could easily be mistaken for an early ash handling facility. In reality, the device is a modern grit collection system. The similarities between ash and grit removal are indicative of the close link between historical and modern waste handling facilities. The plethora of specialized practices and facilities now required, however, is clear indication that mushrooming environmental concern has caused the most significant change in locomotive servicing facilities during the last 100 years. Other new grit removal facilities more accurately depict this change.

Oil/Water Separators

Wastewater processing often involves only oil removal. Specialized process tanks with few moving parts are available for installation in a storm drainage line. Mechanized skimmers are also used.

Treatment Plants

Large locomotive service facilities, with higher rates of contaminated water discharge, frequently require full function wastewater treatment plants. In addition to grit removal and oil/water separation, these plants may include detergent, solvent and other contaminant removal. Each requires separate process tanks or lagoons and disposal procedures. Storage tanks are required for recyclable waste oil. Automated pumping and control systems must be provided. Lift stations must be constructed at strategic points in the collection and process system. Maintenance of wastewater treatment facilities requires B&B crews to possess significant specialized skills and sometimes to assume major legal responsibility.

Legislation

Environmental legislation affects an increasing number of functional aspects of locomotive servicing facilities. Regulations can vary from requirements for pipe labeling or color coding to leak detection, critical standards for treat-

ment plant effluent, or contaminated site soil remediation requirements. Fines and litigation have occurred too frequently. Prisons terms have been threatened. These laws cannot be ignored. The malfunction of even a minor device in a wastewater treatment plant process can throw the effluent out of acceptable limits and force the closure of all major servicing facility. The effects on railroad operations can be monumental.

Fuel Leaks

Recent legislation arising over fuel leak concerns has forced replacement of most underground tanks and frequent pressure testing of underground fuel lines. This is sufficient justification for compact service facilities. When pressure tests indicate leaks may be present, an entire fuel line usually must be excavated to reveal the location of typically small leaks. The majority of the pipe will usually appear excellent. To meet current standards, frequently the entire fuel line must be replaced with a new double containment line with a leak detection system. Cathodic protection may also be required.

Replacing fuel lines with acceptable new systems can be costly and have significant impacts on railroad operations. It seems that B&B people inevitably become ensnared in the environmental twilight zone between two seemingly proven but divergent functional laws. Most agree that attempting to correct a situation that is going bad will produce worse results than letting nature take its course. But yet left to themselves, things always go from bad to worse. Indeed, finally performing a simple mandated leak test can escalate into a complete current standard system replacement and possibly a multimillion dollar cleanup.

Site remediation

The excavation, removal and disposal of previously contaminated soils is a first step for many new construction projects. Limits of excavation should be well defined on design drawings and based on field tests. Even so, excavation usually brings surprises. Field revisions are common.

Containment

Spill and leak containment has many forms depending on application. Commonly provided with new facilities, retrofitting existing facilities has increasingly become a B&B task. Steel or fiberglass collector pans installed directly on ties are common at fueling platforms and

load/unload stations. Cross drains with capacity and design to prevent overflow are critical. Leak proof corrugated metal pipe or concrete trough drains to carry discharge to treatment facilities are also a critical design element. Several railroads install collector pans at locomotive ready tracks or parking areas. One pollution abatement facility where no servicing is provided still required water treatment facilities.

Collector pans are also used for locomotive wash facilities. Some railroads prefer concrete pads with direct fixation rail anchorage for both wash facilities and locomotive service platforms. Secondary containment membranes, complete with independent collector drains, are sometimes placed under concrete service platforms to provide additional protection.

Above ground tank containment typically has a capacity equal to the tank. One committee-supplied example shows lube oil and wash detergent tanks within separate concrete tubs. B&B crews are regularly constructing concrete tubs around existing tanks. Pre-manufactured tanks with built-in steel containment tubs are available for rapid installation and offer a good underground tank replacement solution. Earth berms, sometimes with membrane liners, are typically used around large fuel oil tanks.

Heavy Maintenance Facilities

Roundhouses

The locomotive roundhouse is a favorite historic symbol of railroading. Those with only two or three tracks were hard to recognize, but a few were completely round, encompassing a full 360 degrees. Most covered many degrees and also lived up to their name. Several roundhouses are still in use. Some have been extensively remodeled. One recent retrofit involved refurbishing an inspection bay with new concrete slab, direct fixation rail anchorage and drainage system to create a diesel locomotive wash facility.

Turntables

Turntables have always been an integral part of roundhouses, but were also used alone, sometimes at branch line stub ends to avoid reverse operation of steam locomotives. A "Report on Turntables" in the Association's 1891 Proceedings stated that "No turntable should be less than 64 feet long to allow for perfect balancing of modern locomotives which

are getting longer every year." Locomotives and turntables eventually became much longer. Many turntables are still in use. Some turntables are new, being built primarily for turning snowplows and other unidirectional equipment. One common turntable upgrade is the replacement of outer ring rail timber tie supports with a concrete slab and direct rail fixation.

Heavy Machine Shops

Major steam locomotive overhauls, requiring disassembly, were usually accomplished in rectangular, pull-in shop buildings with heavy overhead cranes. One contributed example, constructed in 1918, introduced a typical series of successively smaller machine shop bays at the rear. Another plan dated 1916 depicted a special lift procedure for a "new" oversize 2-10-2 locomotive. The shop and crane were constructed in 1890.

Heavy Diesel Locomotive Repair

Many steam era heavy repair shops are still in use. Most new facilities are run-through type and may include elevated tracks with mezzanines. Wheel drop tables, heavy lift overhead cranes, locomotive jacking pedestals, wheel truing machines and a multitude of other machine shop equipment are usually included in heavy diesel locomotive repair facilities. Often a material distribution center with easy forklift truck access is located adjacent to the shop complex.

Design/Build - A Modern Approach

Several locomotive service and heavy maintenance facilities described today were designed and constructed in a short 14 to 20 month concept-to-completion time frame, using the turnkey design/build approach. Design and construction phases were overlapped. Bidding and separate construction contract negotiations were eliminated. Once a firm, experienced in all aspects of locomotive service facility design and construction, was selected by the railroad a proposed plan and detailed design criteria were developed and approved. A single contract with guaranteed cost and schedule was then transacted covering both final design and construction. The railroad gained single source responsibility and received the desired facility in the shortest possible time.

Conclusions

Considering the multitude of complex service functions briefly described herein, I believe it is clear that significant change has occurred over the last 100 years and that locomotive servicing facilities have evolved into the most complicated facilities on railroad property today. The vast assemblage of storage devices, structures, distribution systems, machinery, monitoring equipment, chemical process, control electronics and computers required to provide a modern efficient facility and the skills required to maintain those facilities are truly monumental. I believe a high level of appreciation is due the B&B people who amass the vast knowledge required and accept the responsibility of keeping these facilities efficiently operating within desired safety and legislated environmental parameters.

Thank you for your patience and attentiveness. Are there any questions? If not, thank you very much. (Applause)

President Horney: I'd like to thank Dale for that personal effort on his part to hang in there with his cold to do that. Thank you very much, Dale. It was a job well done.

The next item on our program is a standing subject presentation on the use of polymers and epoxies in the railroad construction industry. Mike Bradley, chairman of the standing subjects, will introduce the presenter. Mike.

Mr. Bradley: Thank you, John. As John pointed out, the standing subject today is "The Use of Polymers and Epoxies in the Railroad Industry." With his indepth knowledge in this particular area, Bob Emmerich accepted our invitation to present this subject.

Bob is the general manager of the Osmose Railroad Division. He has a Bachelor of Science degree in civil engineering from the University of Wisconsin and he spent four and a half years with the Illinois Central Railroad before joining Osmose. Bob is in charge of all operations for the repair of concrete, steel and timber structures, primarily for the railroad industry. He is a member of American Railway Bridge and Building Association, AREA, American Society of Civil Engineers and American Concrete Institute. Bob.

The Use of Polymers and Epoxies in the Railroad Industry

Bob Emmerich

**General Manager
Osmose Railroad Division**

Last spring when Mike asked if I would give a short presentation on epoxies and polymers we gave a little thought as to exactly what it is we were after. We decided what we would try to do is go over different usages for epoxies and polymers and talk about some of the pitfalls and advantages of epoxies and do the same thing with polymers. They're becoming more and more useful in the railroad industry and in all types of construction. The one difference is while we talk about this being the construction industry most of this will actually be in the rehabilitation industry which is where we find epoxies and polymers have the greatest use.

We'll start with a simple definition of what epoxy really is. It's a synthetic resin which, when mixed with a catalyst or hardner, will set to a solid. Basically, it's a super glue and it can be mixed with various fillers to form various viscosities of liquids, pastes, grouts and mortars.

Epoxy has many advantages for use in this type of work. High compressive strength, tensile strength and sheer strengths. Compressive strengths of epoxies can range anywhere from 12,000 to 16,000 psi. Tensile strengths anywhere from 5,000 to 8,000 psi and sheer strengths getting up over 12,000 psi. You can find a lot of variance in structural epoxies: High strength adhesion of most materials, this is true of wood, concrete and other products including steel; it has a natural gap-filling quality; it will run through a crack, when properly administered; and it has good resistance to most chemicals. That comes in very handy in certain types of coatings. It's also a good electrical insulation. Sometimes its handy in certain applications, especially in areas of signalling.

It has a lot of disadvantages also. You have to be careful of it as epoxy is a little bit prone to shrinkage and it does have a higher thermal expansion coefficient than concrete. This can be extremely important if you use epoxy in quantity or in volume. You can get some prob-

lems with different coefficients of expansion and creating additional sheer stresses between the bond of the epoxy and concrete; it can be hard to use in the field. You have to mix the various components together at proper ratios. It may exotherm in large quantities, which means that epoxy sets in a reaction that develops heat. If the temperature gets too high, epoxies will literally blow themselves out and become useless; they are very temperature dependent. There are very many different types of epoxies available. Some will set in high temperatures, some are designed to set in low temperatures. The hotter the temperature usually the faster the set.

Packaging of epoxies. Generally there are three basic types that most people would be familiar with: Liquid resins, which are normally packaged in pails or other types of containers; pastes, which would be packaged in bulk pails or caulking tube designs, either a single caulking tube that has to be mixed with a mixing paddle or the new double caulking tube system with a double caulking gun which has automatic mixing nozzles; and, prepackaged grouts. There are many products which already have fillers or aggregates in them which can be bought prepackaged and premeasured and just mixed together. That would be very handy sometimes for field applications with bridge gangs.

Different uses of epoxies. The first one I'll talk about is a bonding agent. Epoxies have been specified in a lot of different repair and construction activities for bonding. It's an application of spraying epoxy bonding agent for gunite or shotcrete. A lot of times epoxy is also specified as a bonding agent for concrete repairs. One of the main things to be concerned about using epoxies as a bonding agent is that you normally need to start with a dry concrete surface. This would be the opposite of most people's experience without a bonding agent of having a dampened or moistened surface.

In this particular slide you'll also notice an epoxy coated rebar, and of course that's made big inroads in most industries to help the protection for corrosion of steel.

Epoxy for anchoring. This is using an epoxy grout to anchor reinforcing dowels. There are different systems for anchoring. This is probably the best system for high volume use. There are also the caulking tube systems which I previously discussed that are very handy for anchoring small anchor bolts and all sorts of other apparatuses since they can generally be delivered right to the hole from the caulking gun and will set quite quickly.

A third type of system is the sausage or the vial system which normally has the two components with a separated file or foil wrapper or some type of breakable container. You set them in the hole and spin the bar or the anchor into the hole breaking the container, mixing the material and setting up the epoxy.

Epoxy grouts for small repairs. Normally epoxy grouts can be used in fairly small repair operations. It becomes very cost ineffective to use epoxy in large quantity for small repair. In areas where you need high compressive strength, epoxies can be very useful. I want to caution you, though. Epoxies for bearings have been used in a lot of places. We have had a lot of experience in using epoxy grouts for bearings and you have to be very careful because epoxies, when you use them in a grout form, will sometimes settle in their mix and create a little bit of froth on the top. If you're using them as a bearing repair where you're pouring the epoxy up to the bearing plate, you might get a little bit of froth. Epoxies, also because of their problem with exotherm, cannot be used in large quantity or for great depths. I talked to one manufacturer just last week who has a very nice rapid set material. However, he recommended that it cannot be used at more than an inch and a half deep and sometimes that's a little shallow for some of the work that has to be done.

Here's another example of a small repair around a bearing area using epoxies. The nice thing in this area is with high strength and good bonds you can get a fairly rapid set allowing you to do your work fairly quickly and then move on.

Here's another example of an epoxy small repair or minor repair. This is a pier that was hit

by a barge. The barge hung up on the pier and scraped the edge of the pier off back to the bearing area. This is a case where epoxy was used for the repair.

It does work very well for joint filling. Epoxy has been used in several places in a lot of the new precast construction using T-girders, box girders and slab sections. We have seen epoxy used in the bearing area, sometimes certain sections are glued down. We have seen epoxy used in other areas, not necessarily the span, but when gluing down certain pads.

One of the main places we have seen epoxy is in joint filling of slabs. There's a lot of discussion and a lot of disagreement whether or not epoxy is the best product for this or whether or not the design requires it. Certain designs require that the joints be stuck together. Other designs are used primarily for a filling application. Again you have to be careful. This design used pea gravel poured into the epoxy. One of the problems in the past with these is that there has been a problem of holding the epoxy in the joint and problems with exotherm due to the amount of epoxy that has been used.

Another place for epoxy is in timber work. There are pastes that are designed to be used with timber for posting work and epoxy will sometimes be used in the joint areas. A lot of times these can be caulking tube systems that can be pumped into a timber pile to help on the joint for a post. Epoxy paste can also be used for shimming work on pile caps and other places like that. One thing I want to caution you about since wood is somewhat flexible, you have to have an epoxy that is somewhat flexible. A lot of the epoxies designed for concrete are very hard. They are so hard they don't have enough flex to move with the wood as the wood changes in moisture, and because of the fact that you get a little more depression in wood under traffic. If you're using epoxies for wood, you always have to be cautious that it is a material with a little bit of flex. Primarily these would lean towards the epoxy pastes or putties rather than your liquid LVs.

Another area where epoxies are used is for exterior concrete coatings like a pier that has a lot of shallow surface cracking and you are trying to protect it from freeze/thaw. It's also been used for coatings where you need good chemical resistance such as fueling facilities or other types of facilities where you want to put a coat-

ing on the concrete to protect it.

That's a general overview of epoxies. I want to talk a little now about the main thing for epoxies that we're most familiar with and probably benefit the most and that would be for crack injection.

This is a good example of a pier that is suitable for crack injection of epoxies. You have a very defined crack line here on this cap.

Here is another example. You have very good concrete and a very defined cracking system which could, if left unattended, result in a failure along the end of this pier. Epoxies can be very useful for the repair of crack systems, however, they can't be used on all structures.

When doing epoxy injection to cracks it's extremely critical that the cracks be cleaned. There's a lot of different publications on epoxy that talk about the fact that you can't use water in a crack because you'll get the crack wet. The problem with that is if you don't use water to clean the crack you won't get it clean. The difference with epoxy injection in buildings and epoxy injection in the railroad industry is a lot of the piers are in rivers that have the tendency to flood and the cracks have been there for many years and are packed with mud and silt. It's very important that the cracks be properly cleaned so that you can get the material into the crack. Cleaning should be done and also checked by using cores to make sure the crack systems are clean. Once they are cleaned, the crack systems should be sealed up and ports installed along the crack lines to facilitate injection.

Injection will normally start at the bottom of the crack and will move up the crack system allowing the epoxy to fill the crack system and allow air to escape at the top.

Epoxy injection requires some fairly sophisticated equipment. This is not a place for caulking tube systems. Normally, injection should be done with proper monitoring equipment and positive displacement pumps which are pumps that will continue to provide a general flow. That epoxy should be mixed through a manifold and delivered for injection.

Injection epoxies are a little different. This is really true of all field epoxies, but especially in this case. We firmly believe that one-to-one and two-to-one ratios should be the only ratios considered for epoxy injection. There are a lot of different ratios out there, such as three-to-one

and up. The farther off ratio you get from one-to-one the more problems you can have in your pumping and mixing systems to provide proper mix and adequate proportion. It's also a lot more difficult to check your proportions if your containers are emptying at a different rate than one-to-one or two-to-one. You can imagine filling two glasses of water. You know when they are equal. It's tougher to say when one is half full and even worse to say when one is a third full.

Another thing about epoxy injection systems is all of them should be color coded; there should be no clear epoxies used in injection crack work. The only way that you can be sure the material is properly mixed is to color code it in two separate colors to develop a third color. That way when it comes out you can check to make sure it's not streaked and that it is the proper color to provide for proper ratios.

We also believe there should be wet bonding. This solves the problem with having a moist crack. It's almost impossible to guarantee a dry crack in an outdoor environment. The proper set times and the proper viscosities have to be researched for the type of work that is being done based on the size of the cracks.

It is very important to monitor your injection. We like to monitor pressures inbound but I want to make a point here. Pressure is not the main avenue for injection. Time, patience and a combination of pressure will provide the best job. Epoxy injection does not require real high pressure. You do have to develop some pressures, normally more than 20 to 40 psi but never above 100 psi. That sounds like a lot if you are familiar with grouting which normally has specifications of 40 psi as a maximum, but in smaller quantities, you can develop a little higher. Most of the times in crack systems you want to keep your pressures well below a 100 psi.

After the injection is completed, we think it's essential that cores be taken. Once injection is done there's nothing you can do to fix it if it's not done properly and the set up is not there because you have just filled the crack with a material you can't get back out. It's basically a one-time operation. It's very important to continually check the work with cores. If cores are specified it also creates a higher level of quality control for the people doing the injection work, which is similar to requiring cylinders for your

structural checks. When you tell a concrete plant that you are taking cylinder tests for these types of strengths, you're darn sure you're getting that type of concrete. It's the same thing with injection processes. With proper injection you can even catch a small crack. Here is a main crack along the core and there's a crack that happened to be caught. This is how a bridge would look after injection where the main crack systems were sealed.

I want to talk about polymers for a minute. They're a little bit different. They are generally a methyl methacrylate which is a mixture of the various monomers combined with fillers, generally sands and aggregates. They have some other advantages a little different than epoxy.

High compressive strength quickly. These types of polymers will generally develop compressive strengths in the 3,000 to 5,000 psi range in two hours or less in temperatures in the 70 to 80 degree range. They have excellent strength adhesion to concrete which makes them a good material to bond against concrete. Their thermo expansion coefficient is similar to concrete especially because they have a lot of fillers which are the same types of materials. This makes them a much better product for certain types of applications where you won't develop internal stresses due to temperature. They have excellent durability and they can be used in a wide range of temperatures. There are some variations in polymers but there are polymers that can be used at 95 degrees, others that can be used at zero. This is always very handy in emergency situations especially in the winter.

Disadvantages. They do have a couple of disadvantages. They do require a primer which epoxy grouts do not. They normally require some very special handling. The main reason for this is some of the materials can be hazardous. Normally the liquid component in polymers can be highly flammable and it's generally a no smoking zone working around them. The catalyst set off polymers can be a poisonous material and these two things make it very difficult to ship by common carrier. With newer DOT regulations it's becoming harder and harder to handle on your own vehicles if you handle it in any quantity. They are also hard to use in the field. A lot of these are three-component systems and you have a primer as another component. Sometimes they

have to be field measured or sometimes you can buy the prepackaged in the proper quantities that you need, but they do require some special handling and some special knowledge and experience to use them right.

Packaging is generally a liquid or a binder containing various monomers. This is normally the flammable material. A bag containing various aggregates and chemicals, normally sand and small aggregate, and with that special chemicals involved with the polymers. Those two are mixed together and then a catalyst is added. The main catalyst is normally organic peroxide. Sometimes you can find polymers in two-component systems where the organic peroxide is mixed in with the sand and aggregate and then you just mix the liquid. There's been a lot of problems with those systems in the past because due to transport, the systems get too hot, or if they set too long, you get an internal reaction in the bag of material and you won't get a proper set. So normally it's better to have a three-component system.

Best Uses. The place for the use of polymers is in bearings. Here's a good example of a bearing that's in need of a little attention. Polymers are an excellent product for redoing bearing areas between train traffic.

This is a new polymer pad right here on a pier top that is being rehabilitated, where before there was six inches of stacked steel shims down in the interior of the bridge seat. In about two to three hours the bridge can be jacked and the area cleaned out and chipped down. If possible the shoe can be removed and reset to elevation. The polymer can be poured and be set and you can run a train, normally in a period of two to three hours. These types of materials will normally set up anywhere from an hour to two hours depending on the conditions.

Polymer can be used in precast work and bearing grillage work. It's a very good material for setting of leveling courses if you're having to do major rehabilitation on a bridge seat and again, with precasting grillages, can be done between traffic.

They are very handy in scale work. With the high compressive strengths of polymers, sometimes exceeding over 8,000 psi and the high durabilities, polymer pads work very well in high impact areas along scale approaches and right at the end of the pit walls in the scales. Because of their quick setting times, you can

normally work in a short period of time and get repairs done on scales without disrupting train traffic for too long a time if that is the case.

Polymers can also be used in old swing spans. A lot of times, both in turntables as mentioned earlier, and swing span sections, the rings get bad with all the oil and the grease and with the deterioration of concrete, the rings start to settle out, the bridge starts to ride poorly and won't set the rest piers properly. In a case like this where you're fighting both train traffic and river traffic, polymer comes in handy to work around the outside of the ring to rebuild the pier top in sections and once that's done the rest can be done with regular concrete.

We have found that products like this work very well in cases like that or in cases of emergency or planned reconstruction of pier tops for swing spans.

I'm sure there are a lot of other areas where people can look at the use of epoxies and polymers but the one thing you want to remember is that they're not a cure-all for everything. They do have special places and special applications and they can provide a lot of benefit. But if you're not careful, these types of materials can be used improperly in the field. They do require special training and some special handling in dealing with the manufacturers to make sure that people understand exactly what the limitations are. They will help a lot as long as you lis-

ten to Mother Nature and the temperatures you're dealing with.

That's it. Thank you very much for your attention. (Applause)

President Horney: I learned a lot from that. Thank you, Bob. The next item on our program is a video and will be introduced by Paul Saletnik.

Mr. Saletnik: Thanks to Mark Walbrun we have the next feature which is a video made in 1940 on the construction of Chicago's State Street Subway. I think you'll find the images of railroad design and construction from 50 years ago quite interesting. Note the multitude of changes in office and work-site conditions since the B&B's 50th anniversary conference.

It is ironic that Chicago is only now extending this subway for the first time, and that soft clay tunnelling techniques shown on the film have changed little since its original construction by a "Department of Subways and Super-highways"; a partnership that today would be considered the epitome of intermodal transportation planning.

(Whereupon there was a video presentation "Streamlining Chicago")

President Horney: This session is adjourned until 1:15 p.m.

TUESDAY AFTERNOON SESSION

September 24, 1991

President Horney: Welcome to the continuance of the second session of this conference. The attendance figures as of noon today are 119 B&B; 184 Roadmasters; 270 Associates; 15 guests and 116 ladies for a total of 704. This is a commendable attendance for a meeting outside Chicago.

At this time I would like to call upon John Creighton, sponsor of special subject No. 5.

Mr. Creighton: Thank you, John. The topic of special subject No. 5 is "Evolution of Protective Steel Coatings" and the speaker as well as the chairman for the subject will be Mark Johnson. Mark began his railroad career with Burlington Northern Railroad in June, 1973, as a rail gang laborer. He held various positions in the track department during the summer months

until April, 1978, when, after earning a civil engineering degree from Montana State University, he entered Burlington Northern's management training program. Upon completion he joined the bridge department as an assistant B&B supervisor on the Nebraska Division. He was promoted to B&B supervisor in November, 1981. Since that time he has held various positions in the bridge department around the Burlington Northern system including region B&B supervisor and manager B&B. In 1988 Mark was promoted and moved to Overland Park, Kansas, as the director of bridge engineering. His current position is director structural engineering for BN's system engineering department. Mark.

SPECIAL SUBJECT NO. 5

Evolution of Protective Steel Coatings

Chairman: Mark L. Johnson, Div. Br. Engr., BN, Overland Park KS

Co-Chairman: K. E. Bruestle, Asst. Chf. Engr.-Dsgn., BN, Overland Park KS
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A. W. Bilancioni, Sr. Mktg. Rep., E. I. DuPont DeNemours & Co.,
St. Charles IL
S. P. Simmons, Supt. Strs. Mtce., ON, North Bay ONT
R. A. Carlsten Jr., Rust-Oleum Corp.
G. D. Ezell, TSD Laboratories Inc.
M. W. Woods, TSD Laboratories Inc.

The "Evolution of Protective Steel Coatings" is a long and intricate study of technological innovations brought about by many truly talented individuals. As with the majority of the topics presented at this, and past Association meetings, to entirely review and discuss all the issues would require much more time than is available, and probably, for most of us, more than is desirable. With that in mind, this Special Subject Committee has dramatically condensed the historical aspects, although some brief information will be presented as a basis for those not familiar with paint technology and/or chemistry. This report will concentrate on the current railway paint technologies and

practices and the events and forces that produced them, followed by a brief look at what the future may hold for protection of steel structures.

The Early Days

The use of paints can be traced to the ancient Egyptians. These water-based paints contained the basic component parts of modern day coatings, pigments, binders and solvents. Respectively, at that time, these were earth pigments, olive oil and an emulsifying agent—egg yolks. Water was added to bring the mixture to the desired consistency. Samples of these types of coatings have lasted 8,000 years. One note of

interest, an early innovation was to replace the earth pigments with tuna fish and a passable lunch was available for the painter. With that bit of trivia out of the way, a giant leap forward will be taken to the more technical and the germane aspects of coatings. Enter the 20th Century and the "Good (?) Old Days".

The Good (?) Old Days

By the mid 20th Century, the basic component parts of industrial coatings had remained, although chemical compositions had changed somewhat. The pigments in use consisted of leads, chromates, iron and zinc compounds. Binders of the likes of linseed, fish and tung oils were being used and large quantities of solvents, such as mineral spirits and turpentine, were commonly employed. Although use of these materials greatly enhanced the effectiveness of paints against the ravages of corrosion, other undesirable characteristics of these compounds led to further advances in the search for the ultimate coating. Enter the 1960s, the Pepsi Generation and the search for the ultimate coating.

The 1960s, the Pepsi Generation and the Search for the Ultimate Coating

Any discussion on the evolution of protective steel coatings would be incomplete without a mention of Weathering Steel. The advent of the use of this type steel began in earnest in the 1960s and continued through 1980 and into today. Weathering steel, also known as A-588 or the trade name Cor-ten, was thought to be the panacea for the ultimate coating for bridge steel. The chemical composition of the steel would produce a protective oxidized coating after the metal had been exposed to the elements for a period of time. Unfortunately, as some of the recent tragic headlines have indicated, the oxidized coating failed to arrest itself in certain conditions, particularly where full wet and dry cycles cannot occur, persistent fog environments exist, in marine coastal areas, frequent high rainfall locations or where debris build-up or chemical attack are present. Although this material works very well in many instances, a number of states have undertaken programs to paint structures where this material has been used. Additionally, guidelines have

been revised to advise caution when specifying where A-588 may be used. Some locales have issued full or partial bans on the use of unpainted weathering steels. The search continues as the 1980s arrive.

The 1980s

A review of today's headlines on the events of the past decade would reveal many words being printed on the economic details of that era: Business mergers, stock market, S&L's, Reaganomics, etc. However, several other issues and events were of a significant nature to have had, and will have, great impact upon the coating industry, the nation's infrastructure and society for many decades to come. Two of these were protection of personal health and the environment. Significant milestones events were: Resource Conservation and Recovery Act (RCRA)—1984 amendments; Clean Air Act—1987 EPA mandates; and Clean Water Act—EPA Enforcement.

The 1984 Resource Conservation and Recovery Act (RCRA) amendments, more formally the Hazardous and Solid Waste Amendments, made major changes that effected the coating industry and practices, including the following: More stringent standards for handling and disposing of hazardous waste; ban on land disposal unless no migration for as long as waste is hazardous; a timetable for EPA decisions on listing additional categories of chemical, plus criteria to make delisting more difficult; and legally mandated deadlines under which congressional decisions become effective, even in the absence of EPA action. This is a very critical group of regulations, especially since many of the common pigments from The Good (?) Old Days are now known to be hazardous.

The 1987 EPA Clean Air Act mandates left the consideration for ozone protection for local enforcement for nitrogen oxides, VOCs and other toxic airborne compounds. Nitrogen oxide is emitted from internal combustion engines. VOC, or volatile organic compound, is defined as any solvent, propellant or other substance, except water, that evaporates from a coating upon drying. A documented fact is that VOCs react with nitrogen oxides to form toxic compounds. As a result of these findings, several states including California, Arizona, Texas, New Jersey, New York and others enacted lim-

its on VOCs. With California, alone, home to more than 13 percent of the U.S. population, such limits are being imposed defacto across the nation and the North American Continent as manufacturers seek economic efficiencies and environmental consciousness rises.

The enforcement of the Clean Water Act placed restrictions on the dumping of certain materials in landfills. These include lead, chromium, other heavy metals and other material found in old paints which are considered to be hazardous waste. Once again, many of the successful products from previous years are environmental culprits.

This decade saw the use of the "high performance" coatings that are prevalent today become much more common for use in the bridge construction and maintenance industry. An in-depth discussion of these types of coatings will follow shortly.

The conclusion should be drawn, as a result of these developments, that many of the aspects of coatings process, from manufacturing of the product to surface preparation to waste disposal to the application procedures, must be changed to protect the workers and the environment from damage. The question becomes "what in the heck are we doing now?"

What Are We Doing Now

A survey of 10 roads, Class Is, regionals and short lines, has indicated most major structural painting programs are a thing of the past. This is not very surprising in light of the current recession, pressure to reduce operating expenses and the uncertainty of future axle loads. However, painting is still done in conjunction with capital expenditure programs, for major rehabilitations or on structures considered to be of major importance. Additionally, some roads specify paint systems for some or all grade separation projects. Of the roads surveyed, about half utilize contractors for major bridge painting projects.

As with many maintenance activities in the railway industry, there is no clear consensus on what coatings are being or should be used and/or specified. In great part this is, no doubt, due to the diversity of those railroads' geographic operating areas. Although some alkyds are still being used, the vast majority use, or specify, what are considered "high performance coatings or paints". Although no clear definition for this term could be found, it is generally

believed to pertain to those products that, when properly applied, stand up well in severe environments. High performance coatings require more diligent conformance to the preparation, application and service criteria than some of the previous popular coatings.

The products currently most generally used or specified fall into four major types: Alkyds, epoxies, vinyls and polyurethanes. These product groups, alone or through combinations, suit a wide variety of applications and can satisfy almost every need. Of course, every project is somewhat unique and, before a coating system is chosen, information on exposure conditions, surface preparation, application methods and drying and/or curing requirements must be gathered and evaluated. Failure to properly do so can result in premature failure of the system.

When evaluating exposure conditions, factors that should be considered are: Heat, abrasion, humidity, presence or absence of salt, pollution and other chemicals.

Consideration of surface preparation for a project cannot be over-emphasized. It is estimated up to 80 percent of all coating failures can be attributable to ineffective surface preparation. Protective coatings adhere to surfaces through molecular attraction between the coatings and the substrate of the steel. As a rule, the better prepared the surface is, the better performance you can expect from the coating. This is one of the reasons that open air abrasive blasting has historically been the preparation method of choice. However, with the air quality, environmental and worker safety standards now having a large impact on how surfaces are going to be prepared, this economic cost-effective luxury is over. The use of containment and collector systems, spent abrasives and other waste disposal and worker protection concerns, including use of respirators, blood monitoring prior, during and after a project, and site evaluations have caused significant increases to the costs of surface preparation. It is now estimated, cost of surface preparation can account for up to 60 percent and more of project coating costs. A trade off in service life of the coating must be made to control these costs.

Application requirements and restrictions must be properly understood. Direct labor costs, employee health concerns and the adjacent property rights must be evaluated when considering coating systems and application methods.

Requirements for drying and/or curing differ greatly with each type of coating. Generally, higher performance coatings will demand more favorable conditions. Once these factors are thoroughly evaluated, the choice of a coating system can be undertaken.

The alkyds are versatile, single-component materials. They resist mild to moderate exposures, require minimal surface preparation, are low cost, easily applied by most methods, have good film build per coat and are relatively free of curing limitations. Performance features of alkyds include excellent flexibility and good hardness, resistance to moisture, mild chemicals and industrial fumes and good gloss retention and weather resistance. Disadvantages of alkyds include limited service life in severe exposures, poor abrasion resistance, fair water resistance characteristics and probably curing problems in areas of high humidity.

Epoxies are considered to be high-performance coatings. Epoxies can be two component materials known as polyamide epoxies or single component materials, known as epoxy esters. As polyamide epoxies are more common, discussion will be limited to this group. These products resist moderate and severe exposures, including water immersion, require good surface preparation, are easily applied by most methods, although spray is preferred for high-build types and require warm temperature for curing. Performance features include excellent resistance to heavy abrasion, severe moisture, including water immersion, and chemical attack. Limitations of polyamide epoxies include not being very flexible, having poor gloss retention, curing at temperatures usually above 60 degrees fahrenheit, having limited pot life once catalyzed and restricted recoat times due to chemical cure. For use where severe conditions warrant high-performance paints, polyamide epoxies are considered to be a good buy for the money.

Vinyls are also considered to provide a good high-performance coating. They are a single package coating, especially suited to severe moisture and chemical exposures. The newest vinyls are called co-polymer high solids and are quickly replacing the older types. One great advantage of the co-polymer types is that no vinyl wash primer needs to be used. Vinyls provide excellent protection in moderate to severe exposures. They also require good surface

preparation, must be primarily applied by spray and cured at low temperatures. Performance features include excellent resistance to severe moisture, including water immersion, fumes and most chemical attack resistance, good gloss retention and cure temperatures as low as 32 degrees fahrenheit. Limitations include less abrasion resistance than epoxies, limited application methods and poor resistance to solvents. When used in the appropriate case, vinyls provide a very good coating system.

Polyurethanes are high-performance coatings that provide the longest life in severe environments. Several types of polyurethanes exist: Aliphatic, aromatic, moisture cured and "modified" urethanes. Two component aliphatic urethanes are the most common and comments will be reserved to that type. As noted, polyurethane resists moderate and severe exposures very well. They require good surface preparation and work best on high performance primers. Polyurethanes can be applied by most methods, although best results are usually obtained by spray and have the advantage over other systems by having no special curing limitations. Performance features include excellent resistance to chemicals, excellent abrasion resistance and flexibility, outstanding long-term gloss retention and weather resistance and low temperature cures. Disadvantages of polyurethanes include strong unpleasant odor during application, and they are not recommended for water immersion. If protection is required in a severe condition, polyurethanes can provide an excellent coating system.

Depending on which source is quoted, current costs of corrosion in the United States range from several billion to hundreds of billions of dollars yearly, especially if such costs as overly conservative design, service interruption losses and other indirect costs are considered. Proper site evaluation, coupled with the careful selection of the aforementioned coatings, can result in a good cost-effective tool to control current and future corrosion problems. What about the future? The Next Generation—Future Systems or Future Shock?

The Next Generation — Future Systems or Future Shock?

As the search continues for the ultimate coating, some of the trends, future systems and possibly future shocks hold some interest.

Some of the trends in the coating industry are fairly easy to predict. With the huge amount of money lost each year to corrosion, emphasis will continue to grow on methods to minimize and/or avoid such losses. The use of high performance coating will continue. Since 1977, the percentage of epoxy resin used in all corrosion resistant paints has grown from 38 percent to 48 percent. Similar increases have occurred for the other high performance coatings.

As the adverse effects become more clear on the use of some of the chemicals employed in the coatings industry, coupled with a rise in environmental consciousness, enforcement and tightening of EPA and local regulations will occur, particularly those pertaining to VOC levels. Several effects of this will result, one being a consolidation of standards creating a "lowest common standard," thus allowing economies of scale. Technology and resources, especially for research and development, will also drive a refinement of current high-performance coatings.

Development of new systems will occur. Several additional systems are being introduced that hold some promise for the future corrosion battle. Two of these are the modified calcium sulfonate-based coatings and the micaceous iron oxide coatings.

The modified calcium sulfonates is a water displacing, high-performance barrier system designed to protect steel in severe atmospheric conditions. Special features of this type coating are its tolerance to poorly prepared surfaces with excellent adhesion to rust, environmentally acceptable by effectively encapsulating old lead paint. These systems are a single package, high solid, low VOC product. Application can be done by a variety of methods, including spray. This product produces a wax-type flexible coating upon application. Some limitations to this product appear to be lack of abrasion resistance and low gloss.

Micaceous iron oxide coatings have been used with success overseas for many years. They are now starting to make a presence in the North American market. These coatings are also a high solid, single package VOC-compliant product. Features include good adhesion over poorly-prepared surfaces, lead paint encapsulation, good flexibility, application below freezing and curing in damp cold conditions at humidities to 99 percent. These products contain organic solvents and polyiso-

cyanates and require the use of positive pressure air flow respirators and hoods. Poor abrasion resistance may result in some instances.

These products represent the good developments of the future. Some darker clouds are on the horizon on the subject of lead and lead encapsulation, this being the removal of lead-based paint abatement and removal issue being pushed by some groups. This issue can become as dramatic in the 1990s as the asbestos abatement was during the 1980s. If this is the case, removal and containment of these coatings will cost industry, including the railway companies, billions of dollars.

The search for the ultimate coating goes on. What does the future hold for the protection of steel structures? Hopefully, coatings that will do a better job for less money. Many of the developments and techniques being used today are a result of increased efforts to go easy on the environment. This is certainly not a bad thing as it is necessary to preserve our environment, not only for our own health and happiness, but for those future generations, our children and grandchildren and their children. Let's hope we do a good job. Thank you. (Applause)

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President Horney: Mark, I want to thank you very much. That's a tough topic to talk about with today's budgets and the bridge paintings that we're all doing right now. But that's not stopping technology and we need to be aware of that. Thank you.

Our next presentation is on handicapped

accessibility and the new federal law. Our presenter is Julee Quarve-Peterson. Julee has been involved in access full time since 1979. Ms. Peterson received her education at the University of Minnesota with a B.S. in housing design and her undergraduate thesis was "Housing Minnesota's Handicapped." Ms. Peterson is a member of the National Council of Examiners for Engineering and Surveying. Her publications include "The Accessibility Book: A Building Code Summary and Products Directory" published in 1986 and, "Simple Solutions to Difficult Problems of Handicap Access" published in 1987. She was also a consultant to production of a video entitled "Removal of Architectural Barriers in Schools".

THE AMERICANS WITH DISABILITIES ACT

Julee Quarve-Peterson

JQP, Inc.

The Americans with Disabilities Act was signed into law on July 26, 1990, by President George Bush. It is a civil rights law, one that gives individuals with disabilities a remedy to discrimination in the areas of employment, transportation, public accommodations, access to state and local governments and telecommunications.

Who might use this new resource? A man with diabetes, who is passed over for a promotion because of that disability; a woman with a hearing impairment who can't call a main telephone number to order tickets to a local sporting event; individuals everywhere who have had only minimal participation in local government because of handicap accessibility issues. For your organization, the law opens new avenues in providing transportation services and job opportunities to people with disabilities.

The federal government has been required to make services and jobs available to people with disabilities for nearly 25 years. The Architectural Barriers Act of 1968 and the Rehabilita-



Julee Quarve-Peterson

tion Act of 1973 guaranteed people with disabilities access to programs, buildings, services and employment among federal agencies and other entities that receive federal funding.

These laws ensured that new construction, remodeling and additions to post offices, schools, city halls and other public structures did not discriminate against people with disabilities.

The Americans with Disabilities Act expands these federal guidelines to local governments and to the private sector. It requires restaurants, shopping centers, doctors' offices and grocery stores to provide the same level of access and opportunity that federally funded structures offer.

The law is being implemented in five main areas: Employment, transportation, public and private accommodations, state and local government access and telecommunications. What are the law's expectations for each of these areas?

Employment

Those who hire workers must provide equal access to job opportunities. This can mean modifying a job site or work site, changing a work schedule or providing specialty equipment, such as a telecommunication device for a hearing-impaired employee. Employers with 25 or more employees must comply beginning July 26, 1992, and employers with 15 to 24 employees have until July 26, 1994, to comply. Small employers with fewer than 15 employees are exempt.



Transportation

By July 26, 1995, every train on existing rail must contain at least one accessible car. As of August 26, 1990, new transit, including rail cars, buses and shuttles being used for public transport, must be accessible. New bus and

train stations must be accessible. Stations in rapid, light and commuter systems are to be accessible by July 26, 1993. Transit agencies can apply for an extension of up to 20 years for commuter rail and up to 30 years for rapid and light rail. All existing Amtrak stations must be accessible by July 26, 2010.



The regulations and specific code requirements were published in July, 1991. Design criteria were set forth in this year's Uniform Federal Accessibility Standards, which gives specifics about door widths; slopes on ramps; railings; positioning of grab bars; space allowances for maneuvering; accessible routes; specialty equipment, such as drinking fountains; and guidelines for signage, parking and other issues.

Guidelines for "accessible" rail cars and "key" stations were also finalized last July. To give you an idea of what to expect, the proposed procedure would require that local or municipal governments that maintain a light or rapid rail public transportation system identify key stations and make those stations readily usable by people with disabilities, including individuals who use wheelchairs.

"Key" stations are identified as those:

- 1) where the rate of passenger boarding is at least 15 percent greater than the average rate of station passenger boarding; or
- 2) that serve as transfer stations on a light rail or between rail lines; or
- 3) that intersect with other transportation modes, including stations connecting with major parking facilities, bus terminals, intercity or commuter rail stations, or airports; or
- 4) that are end stations, unless they are near another accessible station; or
- 5) that serve major activity centers, such as business hubs; government centers; colleges

and universities; hospitals or other major health care facilities; or other common destinations for people with disabilities.

A structure is considered to have an accessible indoor environment if it complies with the July, 1991, ADAG, Americans with Disabilities Act Guidelines. All new construction must comply 100 percent with these requirements. Renovations, additions and modifications to existing stations, including doorways and restrooms, must be readily accessible according to the federal standards. Construction projects in a building often provide a good opportunity to enhance the accessibility of the existing structure.

Public Accommodations and Private Facilities

This third area of emphasis requires that local public and commercial entities not discriminate against people with disabilities, beginning July 26, 1991. This provision affects restaurants, theaters, hotels, museums, libraries, pharmacies, grocery stores; nearly every enterprise, except for member-run clubs and churches.

In these places, physical barriers must be removed, if this is readily achievable, that is, at minimal expense and without undue hardship. Non-physical barriers must be removed by providing auxiliary aids and services. These would include telecommunication devices for hearing-impaired individuals, information in Braille or on cassette for the visually impaired or modified work schedules. Again, new construction and alterations must conform to the 1991 ADAG.

State and Local Government Access

This fourth provision of the new law requires that government facilities, services and communications be accessible.

Telecommunications

This requires companies that offer telephone service to provide a relay service to individuals who use telecommunication devices for the deaf.

How Are Changes Made

There are three ways that a manager of a structure or system might make changes. The

first is to take a proactive role. The Americans with Disabilities Act requires agencies, organizations and businesses to make changes that are "readily achievable" to ensure that their services and structures are accessible to people with disabilities. Again, that means changes that can be made at minimal expense and without undue hardship. For a convenience store, that may mean installing a ramp to replace a one-step entry. It may mean installing an easily-operable door handle or grab bars in the restrooms. It may mean reserving handicapped parking space.

These are all examples of "readily achievable" actions a property owner is expected to take in order to provide access. Many will see



such actions as in their own best interests, since the message of the new requirement is, "there is no grandfather clause." The fact that a building has not been accessible to people with disabilities for the past 75 years does not excuse it from being accessible today.

The second way an owner might make changes is on the blueprints for proposed construction or changes to a structure. Before a building permit is granted, a local building official reviews the plans for construction or



renovation and now, will also check them for full compliance with the accessibility law. Owners whose building plans don't comply, won't get the permit until they do.

If an individual or group believes that discrimination is occurring, property owners might encounter the third method for making changes, which is in response to a complaint. When employment opportunities or access to services is in question, the complainant should communicate directly with the organization which they believe is violating the law. This means saying to the manager of a store, for example, "I can not get through the front door."

Who Enforces the New Law and What Are the Penalties for Noncompliance

If the situation is remedied at that point, no further complaints need be made. However, the complainant is not required by law to make this the first step and may, instead, go directly to investigative authorities.

A formal complaint can be filed with the Department of Human Rights within each state or to higher levels if appropriate or necessary. At that time an investigator will seek out the appropriate owner or agency and determine whether a violation is occurring. For members of the American Railway Bridge and Building Association, for example, the investigating agency would be the Department of Justice or the Department of Transportation, depending on the nature of the complaint.

After an investigation, the agency may issue a report indicating that a particular remedy must occur, such as installation of a ramp or additional signage. If the remedy does not occur, or if repeat offenses are reported, then a judge may impose a fine. In addition to private groups and individuals, the U. S. Attorney General may sue for penalties. One new legal feature of the law is a provision allowing attorney's fees to be part of the settlement. This means that attorneys in private practice will become part of these cases, where previously only public defenders or legal aid attorneys were involved.

Responding to Changes

How should you, as members of the Association, respond to these changes?

First, plan any construction work with accessibility in mind. Remember that although many issues are open for judgment, such as exactly where and when modifications must be made, there is one thing that the new law makes perfectly clear. All new construction, upgrading, remodeling and renovation must be 100 percent in compliance with the Uniform Federal Accessibility Standards as published July 26, 1991, no exceptions.

Second, look beyond structural barriers to the full range of people's needs. Auxiliary aids such as telecommunication devices for the hearing impaired, large print on your schedules and brochures and other measures enhance your ability to provide job opportunities and services to all members of the public.

Third, seek participation of your community in making critical decisions, such as determining which stations and locations must be accessible. Although the federal guidelines assist agencies and local governments in selecting key stations, you might not be aware of the traffic patterns of people with disabilities.

Fourth, realize you are not alone. Take advantage of the many organizations and private consultants who are experts in helping you comply with the requirements of the new law. The Department of Transportation has a special division and a toll-free number to answer your questions and distribute resource materials. The Architectural and Transportation Barriers Compliance Board's technical information number is 800-USA-ABLE.

And finally, rest assured that the law's requirements need not be confusing nor intimidating. By being knowledgeable about them and by being aware of available resources, you are positioning yourselves to take advantage of this opportunity to improve your organization and your service. I wish you the best in doing so. Thank you. (Applause)

President Horney: Thank you, Julee, for that very timely and interesting presentation. January, 1992, is not very far away.

At this time I would like to call upon our immediate past president, Byron Burns, and ask him to introduce all of the past presidents who are in attendance today.

INTRODUCTION OF PAST PRESIDENTS



Left to right: B.T. Burns, W.H. Huffman, E.E. Runde, W. H. Rankin, W. C. Sturm, J. Budzileni, J. M. Williams, J.T. Kapp, D.J. Lewis, R.A. Tallent

Mr. Burns: Thank you, John. Before we introduce those past presidents in attendance I would like to read a note that we received from Miles Burpee, who was president in 1937-1938. This note is in response to a request that he share some memories of the early Association with us:

"Dear Mrs. Weissmann — Sorry to inform you that I am unable to comply with your recent request. I am just recovering from an abdominal operation and still under my doctor's orders. Faithfully yours, C. Miles Burpee. P.S. I recently celebrated by 91st birthday—a happy occasion."

So with that, as your names are called, please come to the front of the podium so that we may get a picture of all of you.

W. H. Huffman, assistant vice president and chief engineer (retired), Chicago and North Western Transportation Company, president 1957-1958; E. E. Runde, construction engineer-structures (retired), Illinois Central Railroad, president 1973-1974; Warren Rankin, senior structural engineer (retired), Burlington Northern Railroad, president 1976-1977; W. C.

Sturm, senior project engineer, Elgin, Joliet and Eastern Railway, president 1978-1979; J. Budzileni, senior structural designer (retired), Illinois Central Railroad, president 1983-1984; J. M. Williams, supervisor B&B (retired), Elgin, Joliet and Eastern Railway, president 1984-1985; J. T. Kapp, project manager construction-design and construction, Conrail, president 1986-1987; D. J. Lewis, bridge construction engineer, Illinois Central Railroad, president 1987-1988; R. A. Tallent, process engineer-track, Norfolk Southern Corporation, president 1988-1989. If you'll give me a minute I'll come down and join you for the picture.

President Horney: Thank you, Byron. On behalf of the Association I thank all of you for being present and suggest the past presidents be given a round of applause, not only for their past service but also for their continued interest in the Bridge and Building Association (Applause)

As past president and chairman of the Nominating Committee, Byron will now present the slate of candidates recommended by the committee for consideration as officers.

NOMINATING COMMITTEE

Mr. Burns: Thank you, John. As I call your name please come forward to be recognized. The nominees are as follows: for president, Mark Walbrun, project manager, Amtrak, Chicago, Illinois; for senior vice president, Paul Saletnik, engineer of buildings, Chicago and North Western Transportation Company, Chicago, Illinois; for junior vice presidents, Don Steele, manager structural scheduling, Union Pacific Railroad, Omaha, Nebraska; and John Van Huis, chief engineer-structures and production, Wisconsin Central, Fond Du Lac, Wisconsin. For treasurer, Don Lewis, bridge construction engineer, Illinois Central Railroad, Chicago, Illinois. For directors with terms expiring in 1994: Bob Carter, general B&B supervisor, Burlington Northern, Springfield, Missouri; Carl Young, project engineer, Conrail, Carlton, Michigan; and Dave Franz, bridge

engineer, Kansas City Southern, Kansas City, Missouri.

President Horney: You have heard the slate of nominees recommended by the Nominating Committee. There being no other nominees, I will accept a motion that the slate submitted by the nominating committee be elected. Do I have a motion?

Member: So moved.

President Horney: Do I have a second?

Member: I second.

President Horney: All in favor signify by saying aye. Opposed? Looks like the ayes have it. I hereby declare these officers duly elected.

We'll continue now with our business session. Will our secretary, Pat Weissmann, please give the secretary's report. Pat.

SECRETARY'S REPORT

September 1, 1990 Through August 31, 1991

Total members, September 1, 1990.....	730
New members since September 1	81
Members reinstated.....	<u>3</u>
	814
Less: Dropped - Active	27
Associate	10
Life	1
Deceased -Life.....	<u>6</u>
	<u>44</u>
Total members, August 31, 1991	<u>770</u>

President Horney: Thank you, Pat. I think that's very commendable of the Association with today's history of buyouts and lower head counts across the railroads that we're able to maintain that kind of membership.

Will the treasurer, Jim Williams, please read the treasurer's report?

Mr. Williams: Mr. President and members, I have here a report that says "Income for the year \$548; expenses for the year \$213.25." Oh, I'm sorry. That's 1891, not 1991. (Laughter) It's a little bit different today.

TREASURER'S REPORT

September 1, 1990 Through August 31, 1991

Checking account balance, September 1, 1990..... \$10,895.81

RECEIPTS

Dues.....	\$10,440.00	
Advertising - 1989.....	975.00	
1990.....	13,050.00	
Interest on checking account.....	464.28	
Executive Committee meetings.....	580.42	
1990 Conference proceeds	3,916.00	
Construction Contract Seminar	8,725.00	
Miscellaneous.....	<u>260.00</u>	<u>38,410.70</u>
		49,306.51

DISBURSEMENTS

Salaries	\$ 9,912.65	
Payroll taxes	825.16	
Employee savings.....	297.42	
Office rent, utilities & insurance	2,178.44	
Office supplies.....	247.48	
Equipment purchase, rent & repair	474.96	
Stationery and printing	2,034.05	
Postage	1,845.12	
Refund of duplicate dues payments	100.00	
Executive Committee meeting	3,194.61	
1990 Conference expenses	601.00	
1990 Proceedings	10,043.08	
1990 Advertising.....	76.00	
100th Anniversary	3,710.40	
Construction Contract Seminar	3,345.91	
Temporary office help & comp.cnslnnt	236.08	
Miscellaneous.....	<u>185.68</u>	39,308.04
Transfer of funds to savings		<u>5,000.00</u>
		<u>44,308.04</u>
Checking account balance, August 31, 1991		4,998.47
Funds on deposit in savings account.....		<u>35,580.99</u>
Total funds, August 31, 1991		<u>\$40,579.46</u>

President Horney: Thank you, Jim. It's a far cry from a couple of hundred bucks a hundred years ago. Are there any questions? Jack Williams, chairman of the Auditing Committee, is unable to be with us today. Wally Sturm will present the report.

AUDITING COMMITTEE

To: Members of the American Railway Bridge and Building Association

Gentlemen:

The undersigned have examined the books of the Secretary and report of the Treasurer for the period September 1, 1990, through August 31, 1991, and have found them to be correct as of August 31, 1991.

/s/ J. R. Williams, Chairman
W. C. Sturm
J. Budzileni

President Horney: Thank you very much, Wally. We'd also like to thank the committee for taking time to go to our "lavish Association headquarters", (I wonder who wrote this) to audit the books. You know, we have to be selective who we put on the auditing committee on the physical size so they can all fit in the same room together. (Laughter)

Next is Don McCammon, chairman of the Necrology Committee, to give his report.

NECROLOGY REPORT

To the President and members of the American Railway Bridge and Building Association:

It is with grief and regret that we report the known loss of six members through death during the past year. It is possible that other members have passed away during the year of whom we have no information. If you know of anyone, please report their names to the Secretary. The following have been reported since our last annual conference in September, 1990:

Edgar E. Burch
Bridge Engineer (Retired)
CMSStP&P
Joined 3-4-45; Died 3-21-91

R. D. Nordstrom
Engineer Bridges & Structures (Retired)
WP RR
Joined 8-31-59; Died 11-12-90

Earl W. Hodgkins
Executive Director (Retired)
AREA
Joined 10-15-58; Died 11-25-90

B. G. Packard
Office Engineer (Retired)
C&NW Transportation Co.
Joined 10-15-54; Died 8-20-90

H. W. Jenkins
Chief Engineer (Retired)
NYNH&H RR
Joined 1-13-40; Died 7-29-91

L. J. Tetreault
B&B Foreman (Retired)
Penn Central
Joined 10-1-36; Died 12-16-90

I would like to ask for a moment of silence in honor of our deceased members.

Respectfully submitted,

Don McCammon
Chairman

President Horney: Thank you, Don. Are there any questions regarding these reports as presented by the Secretary, Treasurer, Auditing Committee or the Necrology Committee? If there are no questions or discussion, I will request a motion that these reports be approved as given.

Member: So moved.

President Horney: Is there a second?

Member: Second.

President Horney: The motion has been made and seconded. All in favor signify by saying aye. Those opposed nay. The motion is carried and the reports are approved.

CENTENNIAL CELEBRATION

President Horney: At this time I would like to lighten things up a bit and get on to our centennial celebration. In less than 24 hours I'll have the honor of joining the past presidents. I believe that the direction of our association has continued to keep pace with the changes of our industry and I hope that the past presidents who are with us today approve of the direction that today's Association is taking. One of the things that has taken place that I would like to make an announcement of this year that has helped our revenue is that we started a session of seminars. This year we had one on contracting and next year I am happy to announce that we will have at least one seminar on bridge inspection which will be given by Don McCammon, Don Sorgenfrei and Joe Lileikis. The cities are yet to be announced but I think this is a credit to the Association in helping reach out to its members across the country in training and education.

Thanks to Wally Sturm, chairman of the centennial committee, we have done quite a few things this year in honor of the centennial. One is the publication that you all got when you registered, the history of the Association. It is all pretty much on the video that has been running in the display room, which itself is a credit to the centennial celebration. We also have Mercantile Library's presentation with a lot of history of our bridges. If you've not had a chance to see that yet, I offer you the invitation to go to the Library during your stay in St. Louis. The Association has worked with them and will be sending them copies of a lot of our original documents so that we'll know that they are safe and they'll be able to keep them and will be available to us. I would hate to think that if anything happened in that lavish office in Homewood, that we would lose a lot of valuable information.

At this time, there's one other thing that I'm quite proud of and I would like to read into the records, that has taken place as of yesterday. There is a letter from Representative George E. Sangmeister of Illinois, dated September 23, 1991, on the following page.

This is quite an honor and will be entered into our records. There's one other thing I would like to do before we break for our anniversary cake and coffee, but there are two people I would like to recognize and invite to the podium to offer a few words of reflection on our history and their association with it.

First I would like to ask Fred Day to step up to the podium. Fred is recognized in our records as having the longest membership in the Association who is still actively employed with a railroad. Fred.

Mr. Day: Well, I don't claim to be the oldest. I see some past presidents here who are older. I'm probably the oldest active member, since 1949, and I've had a great time for more 40 years. I've come almost every year. There have been a lot of good times. We were talking at lunch about the importance of these meetings and it's not always the speeches and presentations that are given, many of which you can pick up off the table, but the communication between the members who come talk to people and get ideas of what other people do to solve problems. This Association is one where you exchange ideas to learn what other people are doing. You get things you can take back with you and that's the most valuable part. I gave a couple of presentations over the years. One of the outstanding ones was when we had Hurricane Agnes back in 1972. We had 25 bridges wiped out and we spent a lot of time and money but we kept the railroad running. Other railroads did too; the Erie was very badly hit. People out west didn't get that. You don't



HOUSE OF REPRESENTATIVES
WASHINGTON, D. C. 20515

GEORGE E. SANGMEISTER
4TH DISTRICT ILLINOIS

September 23, 1991

Mr. John J. Horney
President
American Railway Bridge & Building Association
18154 Harwood Avenue
Homewood, Illinois 60430

Dear Mr. Horney:

I would like to extend my best wishes to you and all the members of the American Railway Bridge & Building Association for a successful Centennial conference.

The contributions of Association members, past and present, to the development of the finest railway system in the world can not be understated.

I hope Association members have the opportunity to exchange information and ideas for many more years to come.

Sincerely,

A handwritten signature in cursive script that reads "George E. Sangmeister".

GEORGE E. SANGMEISTER
Member of Congress

GES:cag



Fred Day

get hurricanes, you get the Wizard of Oz, what do you call them, cyclones. But we have a few hurricanes once in a while on the east coast.

So I'm glad to be here. Listening to these membership numbers we have a very high percentage, from what I gather, in attendance.

Thank you very much. I've had a good time. (Applause)

President Horney: Fred, thank you very much. Next I'd like to ask Joe Lynch to step forward. Joe is recognized in our records as having the longest membership and is still active as an Associate member. Joe told me quite clearly that when he joined the Association he joined as an Active member, not an Associate, but since he's acting today as an Associate member, I'd like to have him speak. Joe.

Mr. Lynch: Thank you, Mr. John. I tell you, looking out here today, it's a great to see everyone, especially Heinie Huffman there. I hate to admit it, but I go back to Heinie's day when I started. And contrary to what a lot of people have been saying the last few days here, John set the record clear. I did not attend the first B&B meeting with Heinie a 100 years ago. (Laughter)

I want to bring special good wishes from two past presidents who are unable to be here. They are very close personal friends. One is Joe DuValle who was president in 1968 and was bridge engineer on the Southern, and Tom Fuller, president in 1972 who was bridge engineer on the Southern Pacific. They said to give you their best.

John asked what were the differences today



Joe Lynch

and in the days past in the Association. I think one of the major differences was the passenger trains. The approach of the meetings before and after World War II meetings were held aboard the trains, as Heinie knows. We would stop en route some times on the Saturday specials on the way to the conventions. Membership in those days was primarily from the rank and file of the B&B supervision. Participation in activities was encouraged from all levels of the B&B and the railway supply industry, particularly those industries who were furnishing material, service and equipment to the B&B departments. The B&B officers and board of directors were a pretty select group of people. And if I just had the nerve I could relate some instances to you you just wouldn't believe. (Laughter) I'll have to say, gentlemen, this is a very meek crowd today than what it used to be. (Laughter) As I look out here and see some that are still alive, it's a wonder. (Laughter)

A lot of enthusiasm and guidance were generated by the B&B members themselves and we had the full cooperation of the railway executives. The officers of the railroads were intent and encouraged the men on the ground to run the show. But all good things come to an end and it was inevitable that changes had to be made, and they have come about through the heavy loads and increased speeds. New technology, new material equipment, and construction methods are just some of the changes that are important to the men on the ground. I have to say this so it will be official. There is one thing that never changes and that's the demand

to reduce costs of construction and maintenance of structures. The B&B departments have contributed heavily to the improvement of operating ratios of railroads. I think back and I can remember when they first started concrete piles and concrete trestles. But during the years, gentlemen, I have had the genuine pleasure and the good fortune to work with the finest people on earth in the American railroad industry. I have shared in the frustrations, achievements and happiness of the railroad people. I've developed a lot of close-knit personal relationships that will remain with me for a long time, in fact forever. I'm happy you asked me today and I want to salute the B&B Association on its 100th birthday and the officers and members who have contributed to the outstanding success of the B&B Association. I hope today we can all look forward to continued success in the second century. Thank you. (Applause)

President Horney: Joc, thank you very much. Fred, I appreciate your words. At this time we have some cake and coffee set outside. We'll take a little break and enjoy a reception and have our final presentation at 3:15.

Recess

President Horney: Now that we've had that little refreshment break I would like to move on with our next presentation which will be given by Don McCammon. Don was employed six and a half years by the Montana Highway Department in construction, both road and bridge inspection and surveying. He graduated with a Bachelor of Science degree in civil engineering from Montana State University and has attended the University of Kansas graduate school. He went to work for Burlington Northern in 1982 and has held positions as assistant roadmaster, assistant B&B supervisor, and assistant structural engineer. Don has spent time as manager of systems engineering computer systems before going back to the field as a general B&B supervisor and his current position is manager B&B on BN's Denver Division. Don was elected to the B&B executive board in 1990, is active on AREA Committee 7, and is also a member of the ASCE and ACI. He is registered as a professional engineer in five states and is certified by the National Council of Engineering Examiners. Don.



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House of Representatives

A TRIBUTE TO THE AMERICAN RAILWAY BRIDGE AND BUILD- ING ASSOCIATION ON ITS 100TH ANNIVERSARY

HON. GEORGE E. SANGMEISTER

OF ILLINOIS

IN THE HOUSE OF REPRESENTATIVES

Thursday, September 12, 1991

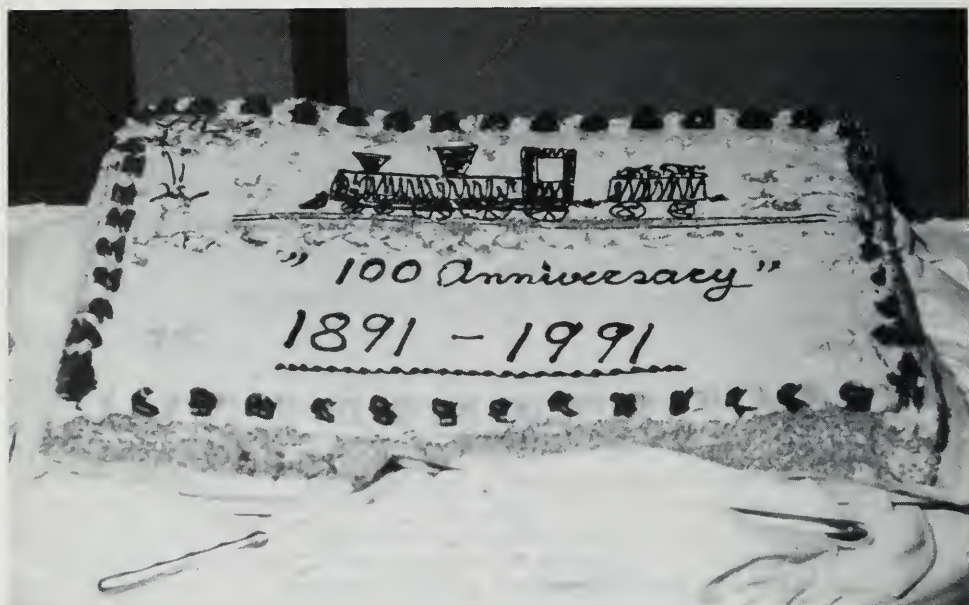
Mr. SANGMEISTER. Mr. Speaker, it is with great pride I rise today to salute the centennial of an organization dedicated to maintaining and improving our national rail system—the American Railway Bridge and Building Association, headquartered in Homewood, IL.

The history of the American Railway Bridge and Building Association closely mirrors the development of American rail travel itself. The association was founded during the golden age of railroading by superintendents, architects and engineers responsible for the design, construction and maintenance of rails, bridges, and buildings.

Since its inception, the association has served as a forum for the exchange of ideas and information among those men and women who help keep our railroads safe and efficient.

More than 2,000 members and guests are expected to celebrate the association's 100th anniversary at its annual national conference September 23–25 in St. Louis, MO.

Mr. Speaker, I would like to extend my best wishes to the members of the American Railway and Bridge Association on a successful centennial conference.



REHABILITATION OF TIMBER LINED TUNNEL NO. 2 AT GUERNSEY, WYOMING

Donald L. McCammon

**Manager B&B
Burlington Northern Railroad**

Over the past several years, railroad tunnels have received much interest. New tunnels were constructed in Canada and several railroads have conducted extensive tunnel enlarging programs to provide clearance for higher and wider traffic, such as the double stacks. Most of this clearance work was done in concrete-lined or rock tunnels using relatively modern equipment such as rotary rock augers. New tunnels have been constructed using tunneling machines, eliminating the tried and true and dangerous hand tunneling methods used over 100 years ago conquering the Cascades and the Rocky Mountains when many of our roads were first constructed.

Tunnel No. 2 at Guernsey, Wyoming, was constructed in 1905 for approximately \$175,000 as part of a line change project that eliminated a very winding route along the North Platte River and included the construction of two other tunnels. This area was first passed by the pioneers on the Oregon Trail and later became the CB&Q's main passenger line through southern and western Wyoming. A dam and reservoir were constructed on the North Platte during the 1930s. This track received a big shock when, in the late 1970s, coal from the Powder River Basin was hauled through this area on its way to markets to the east and south. Guernsey became Burlington Northern's main fueling and light locomotive maintenance location as well as crew change point for all coal traffic traveling through this southern corridor. Approximately 67 million gross tons currently travel this route, all of it having to go through Tunnel No. 2.

Before talking about the history of this timber-lined tunnel and the rehabilitation project, some terminology needs to be explained. The timber lining is composed of several structural elements. A timber set is the main structural element composed of 12"x12" timbers that support a shield structure that prevents rock or other material from falling on the tracks. The

set is usually arched on top for railroads and supported by vertical posts on some sort of foundation. The shield structure is called lagging. To fill the gap between the lagging and the uneven surface created by excavation or blasting of the bedrock, gravel sand or timber (usually called cord wood due to the four-foot length) is used. Longitudinal bracing between sets is usually called collar bracing. The location where the arch meets the posts is called the spring line. Other types of tunnel lining systems exist with special terminology being applied. The above mentioned terms will enable one to navigate Tunnel No. 2.

The tunnel is 1,925 feet long with a timber lining system and timber cord wood filling the gaps. Records indicated that the tunnels in this area were constantly maintained by an assigned crew. Rotting timbers were periodically replaced, posts reset and in the 1930s, 1940s and 1950s, numerous attempts were made to provide drainage. One of these attempts resulted in a drainage gallery and pump providing water to a rancher's stock tank located above the tunnel. In the 1970s, due to use of treated timber and good tunnel conditions, the assigned crew was eliminated in an economizing move.

With the advent of coal traffic, mud started fouling the ballast and the track structure started to fail. In the early 1980s, the BN removed the track and excavated to the bottom of the timber mud sills, where they placed a filter fabric and new ballast. Fouled ballast below the sill elevation wasn't replaced due to a fear of lining failure. The project required the complete shutdown of traffic for a 24-hour period. The drainage system was replaced immediately afterwards. This lasted several years until movement of timber sets was noticed and the mud returned. Normal track speed due to curvature is 25 miles per hour, but a 10 miles per hour slow order was placed.

A number of problems were discovered with the tunnel in the spring of 1989. Approximately

45 percent of the ballast section through the tunnel was fouled with silts and clays, equivalent to the mud geysers at Yellowstone Park. The ballast in the center section of the tunnel was in good condition.

Rotation of the timber mud sill foundation had caused movement of the timber posts supporting the lining. Numerous temporary struts were placed using track ties as part of the blocking to prevent further failure. This movement was located on the east and west thirds of the tunnel with the middle portion in excellent condition. Numerous cracked posts and arch timbers were found. In some areas, the mud sills were not continuous and in one portion of the tunnel, approximately 10 sets or 40 feet of tunnel wall had settled one foot on one side, weakening the arch and rotating in to the center of the tunnel.

The drainage system, which had perforated drain pipe wrapped with geotextile fabric, was continually being clogged with fines and did not have a positive flow. A series of mud pumps was necessary to keep the system operational. In addition, flow from the cut on the west end of the tunnel brought additional fines and water into the tunnel creating further track problems and clogging the drainage. More mud sill failures occurred as more material was cleaned out of the drains.

Golder and Associates was hired to analyze the problems and recommend repairs or remedies to the tunnel problems with an eye toward providing an economical, somewhat permanent solution that would restore normal track speed and eliminate or drastically reduce the maintenance.

This profile summarizes the problems while at the same time giving a good feel for their location. The gradient runs downhill, west to east. Starting from the west end, we see the areas of fouled ballast, the good section of the tunnel and the drainage system. The chart shows the monitoring wells and core drill that were completed along with the topography. About 80 feet of cover exists.

Most of us are used to thinking of hard rock in connection with tunnels. The bed material consists of fine silts compacted into a rock formation that could easily be scratched with your fingernail and would change to mud when mixed with water. This material had to be jack hammered to excavate, which at the same time

completely clogged normal rock drilling equipment that used hammer action. Thirty percent natural moisture was found in the rock with low permeability and high porosity. The material would degrade to 70 percent passing a 200 mesh sieve.

Several options to fix the tunnel were evaluated, from open cutting to stabilizing the existing lining. At over one million cubic yards of material, with questions on ripping versus blasting and a haul of at least five to ten miles, not to mention the additional right of way needed, some from a state park, the \$3 million plus price tag for open cutting proved to be too costly. In addition, alternate lining systems such as concrete, shotcrete or steel were explored with the same large price tags and results. Estimated cost to stabilize the existing tunnel lining, replace broken timbers, provide drainage for the west end cut and reinforce the floor system was \$200,000 to \$500,000.

As designed, lateral reinforcement for the existing sets would be provided by two rock bolts embedded at least 11 feet in the bed material. These bolts would be grouted in place with channel steel extending between posts for additional support. Those sets that had already exhibited foundation failure were to be reset on new concrete foundations founded in the solid bed material. In some instances this bed material was found to be five feet below the mud sill. Foundations were also to be provided between sets in the areas where the mud sills had not yet exhibited failure, but probing showed they were not on solid material.

Work methods were also evaluated, as well as using contractors. A maximum of four hours of track time per day was the driving factor. This provided minimal train delay. The closest siding was several miles away. Approximately 1,300 rock bolts needed to be installed, 60 posts replaced and about 90 foundations poured, along with resetting of posts to original alignment which required complete removal of all material behind the lining, resetting of the post and refilling the void. This did not include the west end drainage.

Equipment was looked at and contractors' proposals were evaluated. It was decided to perform the work with Burlington Northern forces using rented equipment. When work could not be performed in the tunnel, the forces would be used to maintain the Guernsey facility

and the numerous bridges in the area. This decision proved very worthwhile as there were many days when only two or three hours of track time were available as well as occasions, due to train operations or weather-created access problems, that our bridge and building personnel were unable to work in the tunnel.

One of the major questions was the type of equipment necessary to drill the holes for the rock bolts. A hand-operated air drill was used for drilling the three-test holes, however, it took three people to handle it and it would literally throw a person due to the torque. A common jack leg drill was also looked at, however, it was more suitable for hard rock drilling and required a minimum of three people to operate. While visiting a mining equipment supplier, an old bedraggled piece of equipment mounted on narrow gauge wheels was discovered. It was called a "drill jumbo" and seemed to fit our needs when mounted on standard gauge wheels. Our work equipment mechanics installed the axles during the refitting work done by the supplier. The jumbo could be lifted on and off the track very quickly while at the same time providing a safe working platform to drill two holes at one time. A small 1,200 cubic foot per minute air compressor, also rail mounted, completed the drilling equipment.

A small, but very time consuming, problem was finding a drill bit that would work in the type rock in the tunnel. All suppliers immediately discussed diamond-studded percussion bits, when we mentioned rock drilling. However, the pounding action resulted in the soft rock material completely plugging all the air holes and stopping the drilling operation. One supplier attempted to solve the problem by recommending home-made bits, however, they lasted for only a portion of a hole before breaking, losing their teeth or, as a result of both failures, clogging. We finally found a supplier with ties to a Canadian firm, who provided us with a bit that worked. It lasted for 600 holes and can still be used. Best of all, it was half the price of the home-made bits.

Armed with the drill jumbo, air compressor, bits, drill steel, air hose and a machine to lift all that on and off the track, we moved the equipment from Guernsey, where it was originally delivered, to the project site at the tunnel.

Typical work operations at the tunnel included setting the equipment on the track once the

permit was received and moving the equipment to the work location by use of a hi-rail boom truck, which also acted as a work platform for the upper drill people.

The jumbo had the capability of rotating the drill heads close to 360 degrees for complete coverage of the tunnel. Most holes were drilled horizontally at about the third point on each post. Some were drilled vertically up into the ceiling. As each hole was drilled, a section of plastic pipe was placed to maintain hole integrity until the DYWIDAG bar could be installed. You will see the pipe sticking out from the posts. Some of the holes do not have the pipe. The cord wood in these areas slipped as soon as the drill stem was pulled out. We ended up bridging over these with channel section steel or redrilling the hole. Drilling began October 10, 1989, and was completed May 2, 1990. An average production of 3.2 holes per hour track time was achieved at a cost of \$170.00 per 16-foot hole.

Grouting and setting of the DYWIDAG bars started in April, 1990. A portable mixer was used to mix the non-shrink cementitious grout. The grout was pumped through a hose and piped into each hole using a small piston pump. A work platform attached to our boom truck enabled work to be done safely. Our grouting turned out extremely well as shown during later work removing the cord wood, which allowed us to inspect our bar installation.

While the drilling was taking place, a second crew worked on construction of catch basins at the west end of the tunnel. The 1,000 foot approach cut funneled all storm water into the tunnel at this end. The catch basins collect this water and pump it out of the cut and into natural drainage away from the tunnel. Automatic pumps and control panels were provided. The finished work provided permanent pipe supports and additional retaining walls to keep the slope debris out of the basins. In addition, a ballast apron was provided.

Once the drilling and grouting operations were completed and the tunnel sets stabilized, we began the process of cleaning out behind the sets that had moved. Bars were used at the spring line to support the overhead lagging and debris. The yellow flagged nails were used to monitor the post location by laser survey before and after work was performed.

We estimated that an average of four feet of

cord wood and loose rock existed behind the lagging. All this material had to be removed by hand, not much different than the way the tunnel was originally constructed. One of the properties of the rock was that the longer it was exposed to air, the more it scaled off. The debris was hauled out of the tunnel and eventually wasted; the cord wood, mostly pieces of untreated oak, will end up as firewood.

Round concrete foundations were placed beneath the posts that were either being replaced or had evidenced mud sill failure. Square tubing was placed on either side of the posts to support the spring line prior to removal of the post. The foundation holes were then augured in and keyed a minimum of six inches into solid rock. The average depth was three to four feet; maximum was six feet.

We did not see the cost effectiveness of refilling the void behind the lagging with timber cord wood. We could not pack the wood tight enough to prevent rock scaling and it was a very labor intensive process. We found a concrete additive that created what we called "foamcrete," a material widely used in Europe and Japan. A concrete truck would be batched with two to three yards of a sand, water and cement mixture. The foam additive would be placed in the truck at the job site. The truck would mix the ingredients for several minutes creating a homogenous seven cubic yards of material that, when hardened, would weigh 40 pounds per cubic foot.

The crew, as part of an on-going safety process, labeled the equipment so everyone would be able to follow the operation. Compressed air was used to generate the foam as well as push it into the concrete truck through a hose. A timer controlled the entire process. The foam was placed in the truck and then mixed with the grout. After mixing, the foamcrete was poured into a squeeze concrete pump for placement in the void. The work was done in eight to 16 foot segments to reduce the workers' exposure to tunnel collapse.

Drains were placed to reduce future hydrostatic pressure. Temporary forms were placed to hold the foamcrete. These forms had to be lined with plastic and sealed as the foamcrete had a tendency to run and find the smallest of holes. The end result, in the locations where the cord wood had to be removed, was a lightweight material with some struc-

tural strength now filling the space.

Our original schedule had the entire tunnel rehabilitation being completed by this conference. However, as each of you know, in a project of this magnitude the unseen can strike at the most inopportune moment. Two events occurred to delay the work. One was an increased emphasis on running trains on cycle time; we did not see track time for close to a month. A more important delay was caused when we finally started working in the area where the sets had settled. We found 18 feet of rock debris and cord wood above the arch ready to fall if we moved any of the timber lining. It was determined that we could not close the line and drop the material due to the train traffic.

Another solution was developed jointly by engineers from Golder and Associates and DeLeuw Cather to place steel arched sets on each side of the existing timber sets. We placed steel stay-in-place panels between the sets and pumped foamcrete in to fill all the voids and stabilize the loose rock and cord wood. Upon completion of this work removal of the timber posts and arch would be completed, restoring the necessary clearance. This work is currently taking place.

As mentioned earlier we had to do something with our version of Yellowstone Park. This could only be done once the tunnel lining had been stabilized. Three alternatives were developed. The first involved placing geotextile fabric under a layer of sand that had geogrid placed on it to take the tensile loading from the ballast. This option was not discussed after it was determined it did not relieve the pressure wave created by the unit trains on the rock nor would it prevent migration of the fines through the floor and into the ballast.

Two other options were closely studied. One used a new material called geoweb to contain the sand in a honeycomb matrix on top of filter fabric. The ballast and track would be placed on top of this material which would be eight inches thick. Fines could still migrate but the pressure on the rock was reduced. The third and finally selected option involved paving the floor with six inches of hot mix asphalt paving. This was actually the cheapest solution. After traveling to Kentucky to see what the CSX and TTI railroads were doing with asphalt, it appeared to be a good long term solution. Using the design guidelines developed by Dr.

Rose from the University of Kentucky we determined that six inches of asphalt placed in a level subgrade would be adequate to support the track and ballast. Pressure on the underlying rock would be reduced substantially with the prediction that no degradation should occur. To further create a conservative design, 12 inches of ballast would be provided under the tie along with 10 foot ties used instead of the normal track tie.

This work will involve the only major disruption to train traffic of the project. Thirty-six hours will be used to remove the existing track, excavate all ballast and loose material to bedrock, prepare a level grade with compactable fines, pave and place new ballast and track. This is now tentatively scheduled for the end of of October.

The last part of the tunnel addressed was the drainage. The old system with pipe wrapped in thin fabric had failed. In addition, the collection boxes had literally floated up into the track area. Our engineers could not find a long term solution given the potential of the fines to eventually clog any type of french drain. It was determined that a throw-away drainage system would be the best we could do. Collection boxes will be set every 50 to 100 feet with slotted and wrapped six inch drain pipe at a gradient connecting the boxes. Existing sump pumps will be placed in these drainage boxes pumping on the west end to the drainage gallery and eventually up to the stock tank. The east end will follow the natural drainage out of the tunnel.

Next month will see the two year anniversary and, hopefully, the conclusion of this project. While the time frame has been spread out, trains have operated with minimal impact and the crews were available for other work. A maximum of 14 people worked on the project at any one time. In this day and age of reductions, this represents three B&B crews. More manpower will be used during the floor reconstruction. The total cost will be in the \$500,000

to \$600,000 range. So far we have not had any lost time injuries. The closest scare was a piece of lagging falling on a worker's head. His hard hat was the only damaged item. The project itself has been interesting from the standpoint of learning and using turn-of-the-century equipment used in other industries that facilitated this work. The timber lining in the dry Wyoming environment has been a long-lived material. We are now providing a stable foundation so this life span can be fully utilized.

My thanks go to Brent Bronson of Golder Associates and Alan Krause, formerly with Golder Associates, and Roger Koester of DeLeuw Cather, for their engineering designs, studies and advice. I also wish to thank Dr. Jerry Rose of the University of Kentucky for his help and subsequent investigation concerning the asphalt paving. Special thanks go to Russell Rogers of Transkentucky Transportation Railroad and R. F. Turnage of the CSX and their companies for allowing Burlington Northern on their property and to see their pavement applications. The help and advice from L. E. Rivkind of the Mearl Corporation, Dan Senf of Presto Products Company and Bob Pope of Mining Equipment is also appreciated. All the above engineers, fellow railroaders and vendors helped, but the big thanks goes to the bridge and building crew members who safely worked this project (not to mention the loss of their suntans), developed several labor and time-saving pieces of equipment and methods and who will eventually complete a cost effective, long lasting rehabilitation of Tunnel 2 near Guernsey, Wyoming. Thank you. (Applause)

President Horney: Thank you very much, Don. There being no other presentations today we'll now stand adjourned and meet tomorrow morning in joint session with the Roadmasters. Don't forget the reception this evening at 6:00 p.m.

Adjourn

WEDNESDAY JOINT SESSION

September 25, 1991

President Horney: Ladies and gentlemen, we'll now call this final joint session to order. First, our thanks to REMSA for that wonderful reception last night. At eight o'clock this morning our final registration stood as follows: 185 Roadmasters, 119 B&B, 273 Associates, 15 guests, and 116 ladies. Our final count is 708.

I'll turn the program over to Mark Walbrun who will introduce our first speaker this morning, Mark.

Mr. Walbrun: Our next feature is a film on the extraordinary railroad and building construction that went into the erection of the Boeing 747 plant in Everett, Washington. For

those of you who saw the 50 year old film on the Chicago Subway construction shown at the B&B session yesterday, this film today offers another perspective on the construction techniques of that period which was approximately 20 to 25 years ago. During our centennial celebration Monday we remarked on how the B&B special subjects were basically the same ones this year as they were in 1891. It's the method of execution that was changed and as we enter the next century it is wise to keep in mind how much has already changed when planning for what lies ahead.

(Film Presentation)

CONSTRUCTION OF EXTRAORDINARY RAIL LINE AND BUILDING TO SERVE BOEING 747 PLANT IN EVERETT, WASHINGTON

Mr. Saletnik: Mark Walbrun will present our next special feature on the Chicago Union Station redevelopment. Mark obtained a Bachelor of Science in transportation engineering at the University of Illinois in 1974. He is has been a registered professional engineer in the state of Illinois since 1978. He has been with Amtrak since 1971, joining the engineering department in 1975. Mark designed and man-

aged the construction of the Chicago Yard Terminal, the Midwest Reservations Office and the interdepartmental CADD System while at the Philadelphia engineering headquarters. Mark is currently serving as a project manager for all reconstruction at Chicago Union Station, including the passenger facilities, track project, signal replacement and air rights development. Mark.

CHICAGO UNION STATION REDEVELOPMENT

Mark Walbrun

Project Manager
Amtrak



Mark Walbrun

Thank you, Paul. It's not often that one gets a chance to replicate 75 years later what was done earlier. Chicago Union Station was formed in 1913 as a consortium of five railroads to operate passenger facilities in the city of Chicago. It was at one time considered to be the possible center terminal for the entire city but was never actually set up as that. The postal service, though, was an integral part of the operation including a large steam plant. In 1914 this work began and progressed until 1925 and, except for time taken out for World War I, the site was under constant construction.

The facilities that were designed and built in 1914 are actually the same ones that are currently under reconstruction now. Chicago Union Station's headquarters building or the headhouse is located in blue on this plan. It was just to the west of the Chicago River. Tracks enter both from the south and the north and transverse under a train shed that occupies six city blocks. That shed, at one time, was all glass canopies but in 1936 it was overbuilt with the post office and in the late 1960s and early 1970s by a number of office buildings.

Union Station Company, itself, is a totally owned subsidiary of Amtrak, but when it was

formed in 1913 it was a union station with four shareholders, two of which are railroads which later became the Pennsylvania Railroad, along with the Chicago, Milwaukee, St. Paul and Pacific and the Chicago, Burlington and Quincy. The Chicago and Alton Railroad, which at one time was to be the fifth owner, was in financial difficulty at the time, as it was for much of its life, and was unable to join as an owner but was admitted as a tenant.

This is the site as it appears today. The headhouse building consists of an eight story building constructed over a large glass dome atrium. It is the headquarters of the Chicago Union Station Company and at one time, a number of railroads.

The building itself was designed to be 22 stories tall. In fact the foundations were built for that purpose. There are end caps up here on the roof that were designed to be continuing construction all the way up. That work, though, was never accomplished.

Just to the right of the building across Canal Street was where the concourse was located. This was a separate building that was reminiscent of the design of New York Pennsylvania Station. Currently there are two buildings located over the site of that concourse. One is the 222 South Riverside building. That's the white building. The other is the 444 West Jackson building, which at one time was the headquarters of the Chicago Mercantile Exchange.

This is a photo of how the main waiting room of Union Station appeared in 1925. For those of you who have been there recently, you'll notice that it hasn't changed an awfully lot with the exception of the information counter located right here. The main waiting room has been restored to pretty much what it looked like when it opened.

This is a rare color photo of the concourse building that is now gone. This building served as the confluence for passengers arriving and departing through train gates on both south and north.

Chicago Union Station is unique in North



First Class Lounge Fireplace

America and with one exception that we are aware of, in the world. It's the only double-stub station in the world. The trains arrive both on the south and north. There is only one through track. Usually a station of this design would be elevated and have platforms underneath it but this design was much more efficient because Chicago is the terminating point for almost all trains.

After Union Station was completed it remained fairly static until World War II. At that time blackout restrictions forced the painting of the canopy and the large domed skylight which darkened the main waiting room until just very recently.

During the period from 1950 through the late 1960s the owners of Union Station Company were on increasingly tight budgets. The facility deteriorated rapidly. You can see in this photo a number of problems up in the ceiling where we had plaster leaks. The building had gotten quite grimy and dirty over the years. In an effort to make some income, the owners added a series of lockers and retail facilities which were at best, adequate.

The restaurants that were located in the back of the station were, at one time, some of the

best in the city of Chicago. The Red Lion and Golden Lion restaurants which are shown here, lasted until the mid 1970s and then were closed. They had outlived their usefulness and again, there was very little investment made in those facilities.

In this photograph you can see the building as it existed before the fire. There is a large retail facility known as the Isle of Gifts, located in the center of the concourse. Most of the waiting room benches had been removed by this date. A rather tasteless addition was made in the 1940s up on top here on the balcony level. By 1969 the over-build pressures and the search for additional income led Union Station Company to sell the air rights to the concourse building. This building, which was only in existence for a little over 30 years, was then demolished to make way for a new office building.

The headhouse building remained intact throughout the construction. Passengers were routed under the viaducts to board their trains during that time. It was a particularly dismal experience for commuters and intercity passengers during this period.

By early 1970 the tower for the 222 building had started and they were working at capping



South Track 2/4 Area

out the top of the tower. The skeleton for the 444 West Jackson building was also underway.

This is what remained for intercity passengers and commuters after the construction. The concourse was rather bleak. It was filled with retail facilities to the point of almost exclusion of traffic. You can see from these photographs that the level of detailing and finishes in building was, at best, minimal. Bare concrete floors, concrete block walls and open spaced ceilings.

The infrastructure of the building remained unchanged. The baggage facilities dated from 1925 and were barely functional. The electrical system was signed off by Edison himself. (Laughter) This one was built in 1922 and has his signature in the corner for Chicago Edison. It has DC control panels, 32 volt charging systems and a variety of equipment. To this day, we don't know exactly what it all did.

The washroom facilities for the public were located at the end of bleak aisles and, under the best of circumstances, were considered utilitarian.

The retail facilities on the Mezzanine Level, which was a new level added during the construction of the 222 building, was a level above the concourse but below the street level. This level was filled with a variety of shops under

different ownerships with no particular plan in mind for how they would be laid out. The Mezzanine was also filled with lonely, empty corridors and was not a particularly attractive place to walk around at night.

Downstairs in the concourse level, retail was put into every square inch that Union Station could find. These aisles were the main aisles between the headhouse and the trains. You had to crush through here during the evening rush hours and try to make your way to a train with people loaded with baggage and commuters rushing with their briefcases.

When Amtrak arrived on the scene in 1971 it felt that it had a requirement to make some improvements to Union Station. Because Union Station Company was owned by a consortium of railroads, Amtrak was unable to make direct improvement to the facility because it did not own it. It did make certain leasehold improvements though.

One of the first was to open a new-style ticket counter. The ticket counter was opened in 1973 and was the first new Amtrak facility in the City of Chicago. This was shortly after we consolidated operations from the Illinois Central Station at 12th Street over to Union Station.

Across the aisle, the passenger lounge and

the first baggage carousel in the Amtrak system were incorporated. The passenger lounge, although very attractive at the time, suffered from an immediate failure because of its location away from the tracks. Seeing as how it was almost a block away from the tracks most passengers preferred not to wait in the lounge because they were afraid they would miss their trains. That defect would not be corrected for almost 15 years.

The baggage carousel did speed up operations from the basement. The baggage continues to this day to be handled in railroad style where it is checked in and checked out in all stages of its operation thereby greatly missing the chance of misrouting and loss. An employee stands at the entrance of the door and, as you leave, each tag is matched and pulled before the luggage is released.

This is the interior of the passenger lounge. It was built in 1973 and opened in 1974. Although looking fairly attractive in this photograph, it also had a serious problem. It was located under the Canal Street viaduct which leaked tremendously. Water was a constant problem. The ceiling tiles were often stained and there were usually buckets standing in the room.

After a while Amtrak opened the first first-class lounge for its sleeping car passengers in a portion of the old lounge. New furniture was added, a few trees and lighting and this gave us the first idea of a trend that would occur about five years later in first class lounges around the country.

In 1983 a disastrous fire occurred in the rear of the headhouse building. The location of the old Golden Lion and Red Lion restaurants was the scene of an electrical fire which gutted the remaining portion of the building and tremendously damaged the skylight over the building. We are currently using part of this fire-damaged area for temporary parcel storage. The advantage it did have for us is that the insurance proceeds were used to build the skylight dome.

This is the main waiting room after the fire. The Isle of Gifts had been removed. Although you can't quite see it in this photograph, the dome skylight has been completely opened up. This brought light down into the concourse for the first time since World War II.

About this time Metra came on the scene. The existing commuter operations at Union Station, primarily the Milwaukee Road on the north and the Burlington Northern on the south,



South Boarding Area Escalators



Ticket Counter Soffits

along with a number of smaller roads have eventually given up their commuter operations to the Regional Transportation Authority. After years of fractious debate, the RTA finally settled on a scheme for funding the various agencies and Metra was born out of the scheme. Metra took over what was formally the Union Station Company ticket counter which had inelastically been built on the site of the old location of the former ticket counter in 1974. The Metra operations began immediately to increase the patronage in the station. The traffic level on Adams Street is absolutely tremendous. There is in excess of 60,000 people walking down this street in the evening headed toward Union Station. Anyone who has ever attempted to come out of Union Station during the evening rush hour through these doors knows what it feels like for a salmon to be swimming upstream.

The Jackson Street entrance on the south is also a heavy point and has been building up more and more. It handles about 25 percent of the traffic coming into Union Station.

One of the major problems that Amtrak continued to face in Union Station was the fact that the commuter traffic and the rush hour conflicted with its main evening departures of its intercity trains. The travelers who were attempting

to work their way through this maze were generally run over by the commuters, if they could even work their way through it at all. The traffic levels at some times were so intense that we were unable to figure out a way of getting people out of the building without severe backups on the escalator.

In 1982 Amtrak provided its first plan about how it could reconfigure Union Station. The nucleus of the plan is somewhat similar to what eventually was accomplished. The idea was to develop a space in the rear of the station for boarding lounges for Amtrak passengers. This corrected the main defect we had previously of the old lounge location almost a block from the tracks. Unfortunately, the area in pink was leased under long-term leases to retail facilities that did not want to give up their space. The other areas of the station were still unsuitable for commuter traffic. Although it had acquired 50 percent interest in 1976 due to the Penn Central operation when it was converted to Conrail, Amtrak was not an owner of Union Station. The 50 percent ownership, though, did not allow for the board to vote any capital improvements. The other two owners, Burlington Northern and the Milwaukee had 25 percent each, and no particular feelings toward expan-

sion of the station as they were struggling at that time also. The change came in the early 1980s when the Milwaukee Road went into bankruptcy. Through an arrangement with the Bankruptcy Court, Amtrak was able to buy the Milwaukee Road's 25 percent of Union Station stock which gave us 75 percent ownership. Burlington Northern quickly sold out its 25 percent, not wanting to be dragged along in an expensive capital upgrade.

Amtrak then commenced a search for a developer to redevelop Union Station under similar lines as to what was done in Washington, D. C. Eventually U. S. Equities was selected as the finalist in that plan. U. S. Equities proposed building a twin set of towers on the existing foundations that were to support a 22 story building on top of it. At that time the office market in Chicago was extremely hot and this became a very attractive development. It suffered from a major problem though, in that railroad operations were scattered throughout the headhouse building and into the concourse and had to be rationalized before any such construction could begin. That led to a project known as Passenger Facilities Improvements.

At that time PFI was simply to be one of the smaller projects in regards to the larger development of the headhouse. It actually turned out to be the major centerpiece of the station.

A set of criteria was originally formulated and put to the board of directors. An initial budget of \$32 million was adopted and a major capital program was to spring from this operation. The plans that came out envisioned a complete change in how the operations at Union Station were to be handled. Previously all traffic from the headhouse entered through a center ramp, worked its way through the retail facilities and then down to the track gate on either the south or the north.

Commuter traffic entered through a series of escalators from Adams Street and Jackson Street, through the mezzanine and in through another escalator bank and merged with traffic coming from the center concourse down the center aisle and out to the gates. This plan envisioned a major change in that flow. Travelers coming from the headhouse would proceed down a series of corridors along the outside of the station, through a rampway that had to have major structural changes made to it. These

changes allowed the traffic to flow and avoid the congested center section of the station. The escalator banks were relocated to the outside. This allowed travelers coming from the street side to enter directly through these escalators and out through the gates. This, in effect, separated commuter traffic. The Amtrak passengers were then free to walk forward through the Amtrak ticketing area passenger services then into a series of boarding lounges. This allowed the major change in the operation of the station. In effect, it stopped the cross flow of traffic between the north and the south sides in the evening rush hour.

With the change in plans, commuters coming in at Adams Street enter directly down on the north side and directly down on the south side. This also opened up a tremendous amount of retail space in the mezzanine that previously was pretty much unused.

The main Amtrak entrance would continue to be on Canal Street and would be a straight shot down off Canal Street and directly into the passenger lounges.

Since we still had limited ownership, we made minimal amount of improvements up on the street side. The major items being two new skylights that let direct sun into the lower concourse for the first time since 1969. We also extended the passenger kiosks where passengers enter at Adams and Jackson streets further out.

The search for finishes at the station started with a number of stations around the country. One of the ones looked at was North Western Station. Although this was a very clean and modern station, laid out it was also very stark and cold. The architects felt that if we were to develop a friendly passenger terminal for intercity passengers we had to use warmer colors and a more pleasant environment.

The model that was eventually chosen used a white terrazzo floor with light pink accent strips and dark green coving strips. The columns and vertical elements were sheaved in a dolomite limestone that was quarried in Northern Minnesota. The accent strips along the ceiling were quarried in Italy and the light fixtures here were custom fixtures designed by a firm in Chicago and added to the tan open panel metal ceiling for easy access for maintenance.

One of the major advantages of these kinds

of materials is that they are very low-maintenance types of material. We can put them in and with minimal care they will last for many, many years.

We still had to determine a number of factors on how to insert this new station into the old station plan. The traffic level is quite complicated. You have Amtrak passengers arriving at Canal Street, entering and going into passenger lounges. You have commuter operations going on downstairs and through the gates and also across the mezzanine on the top. Utilities are laid all through this network and one by one we had to take each one out and replace them.

The commuter path that was chosen for most of the operations was a simple and direct path. Basically, the commuters will respond to whatever is the shortest path between their trains. We cannot change them by signage or any other means. So we elected to follow what they would naturally do anyway and designed the station that way.

For an example, this entrance at Jackson Street comes in through the foyer, down the escalator, across by a few stores, down the next bank of escalators and they're down to their gates. It's a very efficient and very quick movement into and out of the station. We estimate that we have about 15 seconds of transit time for every commuter entering into the station.

This is the Jackson entry with its terrazzo floors, revitalized escalators and a series of stone panel walls and a new ceiling.

Similarly, on the Burlington side, because of the traffic levels, we increased the escalators from two to three. During the evening rush hour these escalators actually run in a down direction. We have a counterflow escalator in the center of the station to handle reverse commuters. These escalators are also notable because of their staggered positions. This was done because people have the tendency to make a left turn as soon as they come off the escalator and this way each one of them will form a "column left" in military terms, rather than an individual left, running into each other. The escalators are dual speed. They operate at 90 and 110 feet per minute and that's switchable from a console we have in the main office.

At the gates we faced another problem. During the morning rush hour there were severe backups on the platforms for those entering into the station. We felt that this was due primarily

to the old eight-foot gates. Even though the platforms are 13 feet wide, the gates were only eight feet wide. We widened the new gates up to a portal opening of 20 feet with a 12 foot section of gate door that opens up and thought that we might be able to make major improvements on traffic flow coming in in the morning.

Over at the Canal Street entrance where most of the intercity passengers arrive, we looked at a variety of configurations. As of this date, the upper portion of Canal Street is a separate contract and is still undergoing major design changes.

Down in the Amtrak lobby at the base of the Canal Street escalator, passengers are faced with a fairly easy set of directions. They either turn to the right and pick up a ticket at the ticket counter or they go straight ahead to board their train. This dramatically reduced the amount of confusion going on in the station. We also provide an information board which shows an outline and floor plan of the station and where it's located within the city of Chicago along with a bank of screens which show all the stops Amtrak trains make, what time they leave and what gates they leave from.

The ticket counter was a radical departure in Amtrak's existing design. It was designed with an art deco modern type of design that blended with the old station using new materials. It's an open ticket counter that allows passengers and ticket agents to converse freely. The baggage operations are handled airline style right behind the counter through a conveyer belt that goes directly to the basement.

The passenger lounges were also of a new design. This is, again, similar to an airport departure lounge. The main difference being all the glass. That has served to take care of one of the biggest problems we have been facing in that passengers were always worried they were going to miss their trains, they like to see the trains. So by providing all the glass, we were able to not only control the crowds but also keep in the air conditioning and heating and allow the passengers a sense of security that their train was not leaving without them. They could sit down and relax and wait.

To begin that project we first had to make a few experiments to make sure that these theories were correct. This was an existing eight-foot gate door on tracks 14-16 that we attempted to make the first change to. We

ripped the gate down and widened it and almost immediately we reduced the backup. In the morning we reduced the unload time by a minute and a half for the commuter trains. That's pretty significant because these tracks are used continuously in somewhat as close as ten minute increments, in and out in the evening and morning rush hours. Being able to speed people up that much we could get the equipment out faster and we could open the track for more trains.

We also added new signage all around the station. The old station had very lightly lit signs. They were very difficult to find and it made marketing rather difficult for Metra.

We also improved the old baggage check-in counter which was to be used until the new ticket counter was put in shape. We also opened up the old skylights here to the street for the first time and experimented with materials that would take care of the water filtration problem that caused their closing up years before.

We tried to increase capacity in the main waiting room because we knew during construction we would have to handle most operations in the main waiting room. We tried to clear out everything that was not germane to that. The Traveler's Aid waiting room was built in the mid-fifties and it really clashed with the architectural styles in the building, so it was removed and the walls were cleaned and temporarily relocated to a corner of the room.

A smaller children's play area that had been located against the area damaged by fire was rebuilt, using materials from stores that had been abandoned during the construction and serves until the new children's play area opens up in about two months.

As I said earlier the domed skylight was cleared after the fire and reopened for the first time.

One of the other problems that we faced was how to handle announcements in that main waiting room. One of the best techniques we found was from Toronto, Canada. It's a set of speaker balls, sound spheres, and these are hung from the ceiling. They have been painted in color and match the ceiling and you can barely see them when they are up there. They provide extremely good sound quality for the type of room they are in. It's a very hard surface and very difficult to make announcements

in, but we feel we are getting probably the best technology that we can get with this system.

The other thing that was improved was the old passenger arrival/departure system. The arrival/departure screens are the key for most of the intercity trains and very useful during disruptions on the commuter operations.

We added a master clock system. The clocks throughout the station were reconnected to the system. We have an antenna on the roof that picks up the signal from Boulder, Colorado, and syncs it to the atomic clock. We decided we didn't want any more late trains because the clock was wrong.

We moved the information counter towards the main waiting room so it could house both the old passenger lounge and the main waiting room during construction.

Then the process began. One by one the store leases were terminated. The area was walled off as best we could in that facility. Temporary signage was installed and demolition began.

Now, we're working through three strata here. Major changes in the 1960s, 1940s and in 1920. The plans, as usual, were not accurate. We ran into all kinds of fun things behind the walls that no one had any idea what they were. Demolition got worse. I was beginning to wonder if we were ever going to see a station again. Little by little we began to slowly see some of the walls taking shape.

One of the first things we had to do was construct the loading dock downstairs in the basement. Surprisingly, Union Station had no standard truck level loading dock and that was to be critical during construction. So that was one of the first things built.

Immediately we began a phone line relocation. New phone cables and utility cables had to be brought into the building. The old ones dated from 1925. The signal equipment inside the station which controlled the approaches to the station, bumping posts and track circuits were completely rebuilt and wired. The power system signed by Edison that you saw earlier, was replaced by modern electrical.

The station was previously theoretically air conditioned. The entire time I was there I never noticed it. No one actually claimed to me that it worked. We put in a real air conditioning system this time and it does work. It is always strained by the fact that during the rush hours the doors are opened throughout the station but

once past rush hour it works very well.

One of the more difficult things we encountered in doing the station was the fact that so many utilities festooned the station. You never knew what to cut, what was real, what wasn't running something. It was a tedious task by some of the best technicians that I have ever met. They went down and traced, one by one, every pipe, wire, conduit and item that they could find in that station to figure out what it was and decide how to remove it and get it out of the way. To avoid this from happening 50 or 75 years from now, we color coded every single conduit and wire and pipe in the system. There is a color code chart painted on the wall that explains what all the pipes are. Hopefully, they won't paint over it. They are painted even though they are behind the walls and ceilings in the station. It was a very small component of a \$33 million job. It probably cost about \$20,000 to paint them all. I believe it will pay us back many many times in the future.

This was part of the old loading dock and was to be converted into employee welfare facilities. We tried to use easy-to-maintain parts and pieces yet very attractive ones. We wanted the employees to feel that this was their facility and that it was being built as a partnership. We have 2,000 people employed in Union Station. We took large areas of the station that never had facilities in it before and built up floors and walls to standard level and installed plumbing and lighting fixtures.

Downstairs in the old baggage office, as you saw in one of the earlier photos, was one of the earliest changes made. This was one of the most difficult rooms to construct in the station. Unlike almost everything else in the station, this stayed where it was. We previously moved everything from one location to another. Basically we would operate the old facilities until the new one was ready and then we would move into the new one. There was no other place to put the baggage room so we had to construct it while it was in service which meant working late at night and on weekends whenever we could to try to get the facilities needed into the building. It is still under construction and has been for over a year. One of the first things added to it was a set of new conveyer belts which would go to the new baggage conveyer upstairs and these had to be worked around the old baggage conveyers and cut in.

You can see the old baggage conveyer network going over here and the two actually cross right in here so our conveyer contractor worked out a special jig that would allow us to go this way for a while and then shift it to go that way when we had to work over there.

The baggage claim offices were completely rebuilt. Baggage operations are fairly heavily industrial facilities. This was all block wall construction throughout that room.

Up on the concourse level we did a major change to the way the building was arranged. We moved the building out by about 26 feet. This wall over here used to be the end of the building and we moved it out to the end of the structure line right here. This was space for a trackway that was to be put in here years ago but was never put it. It was for a second through track. It suffered from a major problem, there is a column dead ahead here to support the Adams Street bridge and the cost of removing that column would basically be the cost of removing the Adams Street bridge. So we decided we could much better use the space for the building inside. That's the expanded section. The wall was moved from over here all the way out to over here. This track has now surprisingly got a whole new life. We extended the platform all the way through it. This is the only through track in Union Station that has a platform against it.

You can see from the length of the main concourse upstairs the old finishes and facilities that you had throughout the concourse. That was ripped out little by little, under traffic, every single night and replaced with the new facilities.

This is the beginning of the new south boarding lounge. The truss you see is one of the trusses that you saw in the earlier film. We decided to expose it as an architectural feature rather than trying to cover it up because we wanted to keep the main waiting room kind of airy and open. This is how the main waiting room looked on opening day about six o'clock in the morning. This room, by the way, is completely filled now every single night from about 3:00 p.m. It has 600 seats.

This is the queuing area where the passengers wait for the train. This is all terrazzo construction and new type lighting in the ceiling. The glass wall that you saw extends along the length of the queuing area in the back by the

old train gates.

One of the main keys to this was the north and south ramps on either side. There was tremendous structure work to be done downstairs to be able to insert these ramps, but they were a key to the operation of the station. The ramps are in service now and have proved a definite advantage to the operation of the station.

This is the south side escalator bank. This is how they were under construction during part of the demolition phase, and how they look today. On the north side there is a similar set.

The north side skylight has some of the best views in Chicago. It made a major difference in the lighting in the station area during the morning and evening rush hours. On a clear day you can see the roof of the Sears Tower right through the top of the skylight.

The main headers for each one of the gates were installed along each gate on an individual basis as we would take each gate out of service. Eventually we were able to extend the entire concourse. We worked one gate at a time.

This concourse design is very clean. Everything is recessed. Newspapers, mail boxes, everything was kept out of the concourse floor so that it would be a nice, clean and attractive facility.

The washrooms were of particular concern. One of the most common complaints from Amtrak passengers was poor washroom facilities. Commuters had even written an article in the Chicago Tribune about the time we were doing this design. We knew we had to get good washrooms in the station, no matter what. We threw out all the old designs and started over. We got rid of the hanging partitions which tended to get loose and banged up and replaced them with full masonry walls covered with tile. We used standard hollow metal doors with standard door fixtures on them and hand built each one of these stands. This has been in service now for over a year and this photo was taken only a week ago. You can see that they are kept up extremely well. I believe they are some of the best public washroom facilities that you are going to find in any station anywhere. All this additional custom work on the partitions and everything else added a total of \$5,000 to the design of the washroom.

During this time the Amtrak ticket counter was under construction. This was a particularly

trying time for our people because we kept large areas of the station open and with the wind blowing through it was uncomfortable. The people in the ticket counter were pretty upset that they were moving from a closed ticket counter to an open one although we kept telling them that the air conditioning and heating would be there by the time they moved. You can see the baggage service here at the ticket counter. There is a scale built right into it. To avoid injuries the employees are not allowed to lift more than 50 pounds and that's the limit on our baggage checking operation.

This was the first ticket counter designed for our new computer operations. This is a completely computerized reservations and ticketing system. Reservations are made here and the tickets appear here. They are hidden by a turret on the front of the counter that you can see right here. So the counter appears very clean. All of the computers are hidden back in this area. Up here is the call board that calls you to a particular agent.

Metra's ticket counter was also redesigned although they had different specifications. Metra's counter is located just to the left of the Amtrak ticket counter and they have a very wide area in front of it for the monthly ticket holders. At the end of every month there are huge lines here because people wait until the last minute to buy their tickets. In the past, they used to block the corridor with those lines. Now by having that large expanse, they have space to do that.

This is the baggage claim area. There is a large space in here that was dedicated for handling the two new luggage carousels that would be built. We have a directory board above each carousel to tell you which train and what stops it made and where your luggage is coming up. There is a large amount of space in this room because when we unload a train we may have as many as 900 people on it. Between 400 and 600 have luggage checked, so we need a lot of room for them to stand around these carousels.

Passenger services, which was previously in a closet in the back of the station, was moved to new facilities. They have a new office with an anteroom with a counter to handle special requests and a small waiting area to the right for people with special handicap problems. The counter was constructed of the same design as you saw earlier in the station, with wood finish

on many of the areas that matched some of the earlier station work.

The control center for the station is in this room. There are a variety of information monitors here that are set from a unit right here. This unit monitors the escalators, the temperature throughout the station, the closed circuit television camera and a company business computer over here. It is supported by a group of amplifiers in the back here that actually is one of the largest public address systems around. It has ten square city blocks, that's the entire station, all the platforms north and south of the station, plus all the ancillary areas. You can make public address announcements throughout the entire facility. The public address system is connected to the arrival/departure system so that when it is time for a train to depart it will automatically make the announcement. The other item connected to it is the fire alarm system. Rather than just sounding a horn, the fire alarm system tells the public address system where the problem is and then it makes an announcement giving specific instructions for that area.

Over in the taxi court area in the southern end of the station, new doors and new signage was installed and the new corridor slowly began to take shape.

Amtrak finalized the design on the first class lounge and tested it in New York. This was the lounge under construction and this is how it opened. This lounge is for any passenger having a sleeping car or, in the case of the east coast trains, a club car, and gives some space to enter, relax and sit around. We even have a fireplace. After all, this is Chicago. We have a television set, information monitors and a direct door for boarding passengers. It's a very comfortable environment for anyone waiting a long time for a train. Because Chicago serves as a hub we often get people in at eight o'clock in the morning who aren't going out until four o'clock in the evening and this gives them a home away from home. There is a complimentary beverage bar also associated with it. Our revenues on our sleeping cars are some of the highest we have. We command rates as high as \$1,500 round trip to California on some of our sleepers and they are full all the time. We felt the passengers deserved a facility that matched the kind of money they are paying for.

There is an area across from the first class

lounge for nursing mothers and for mothers to wait with small children. They have baby changing facilities, a place to rest and this facility will be adjacent to the new children's play area.

Upstairs on the mezzanine level things look pretty much as they did before. Right now we have just started on that level. We ripped it up and put the new floor down. The ceiling is open and retailers will be in this area. The wall you see back here is going to be taken out and set back 26 feet. That's the same extension of the building you saw in the earlier slide where we moved the building closer to the tracks. What this allowed us to do was open almost 4,000 more square footage for retailers and that is what made this project work. The retail revenues are able to support almost three-quarters of this project. The way this project is financed, out of \$32 million, \$7 million is from Metra for commuter operations, \$3 million from Amtrak and the remainder is private financing.

Up on Jackson Boulevard, the new entrance was pushed out from the old Mercantile Exchange Building which allowed new light into the space. The orange light you see on the bottom is the old temporary lights still under construction on the mezzanine level.

Over on Adams Street we extended the canopy out so that people who are walking out during the rush hours have space to open their umbrellas. In the past they would wait behind the doors, clogging up the escalators and stopping the flow of traffic.

On the other hand we haven't talked much about the main waiting room. Because of the real estate market going downhill rather rapidly in the last few years, plans for the over-build project were put on hold.

The headhouse building located at 210 South Canal Street was the headquarters of most of the railroad operation during construction but it had a number of significant problems that, regardless whether we were going to do a commercial project on top of it or not, had to be addressed. One of them was the filthiness of the building. You can see in this photograph the Adams Street front had been dirty with coal soot since almost the 1930s and had never been cleaned. You can see on this phase we had just finished cleaning the Canal Street frontage and the building is now white rather than a dingy brown gray. They tell us it will probably stay

that way for about 30 years. The method used to clean the building was actually quite simple. It was just water under pressure of 225 pounds per square foot and injected into the limestone. When it leeches out it dries and is washed down again and the building is cleaned. Unfortunately the process looks awful. For about the first three weeks the building looked terrible with streaks and stains all over it. All the crud that was inside the stone had come out to the front of the building and a lot of people were threatening me with my job if it looked like that much longer. After many nervous meetings with the cleaning contractor, he assured me it would all go away once the sun started shining. I spent a lot of sleepless nights for a few weeks but he was right, eventually it did clean up. I wouldn't want to go through that again. They didn't warn us what it would look like in the interim.

Inside the building the dome looked like a sieve. Every time it rained there were buckets all over the place. We went to work on the roof and started sealing the glass. One by one the glass panels were pulled out and resealed. We found there was a significant error in the construction back in 1925. The expansion plates on the roof girders were welded directly to the building frame and left no room to move. So every time it warmed up or heated down this whole thing contracted and expanded pumping up the glass and pushing holes in it. We had our structural engineers re-evaluate it and they disconnected the connections and remade them with an expansion capability. That stopped the leakage almost immediately.

We also began to refinish the benches one by one in the main waiting room. We have not placed them into permanent position yet. They were in irregular order in 1925. As soon as we finish with that we will be done.

The sidewalk around the station was in severe straits. It was also the roof of the taxi road. There is a little roadway that goes inside the station down into the basement into a loading dock and back around and out the other side. The roof of that roadway was a sidewalk and was caving in in many places. A hole opened up one day almost three feet wide. Something had to be done. Rather than waiting for the developer, we took it on ourselves to take the sidewalk down and rebuild it. These are the old steel frames and, surprisingly, they

were in very good shape. We did a magnetic particle test on the weld and basically certified them for another 50 years. We had a few beams that had to come out but for the most part we were able to use the existing structure. This now surrounds three-quarters of the building and will soon be completed.

After we had cleaned the walls we began working on the old metal frames that surrounded the windows. They were pretty much corroded and we wire brushed them down, applied primer and painted them. We sandblasted the old windows and then added the names of the five original railroads that formed Union Station.

Along with the headhouse building we were also facing severe difficulties with the platforms and canopies that fed the station. While the station occupies two of the ten city blocks, the platforms and canopies actually occupy the remainder of a much larger area. One of the problems was lighting. The station was lit to between one and two foot candles with extremely inefficient incandescent bulbs. Our standards call for 15 foot standards on the platform. Little by little we began to work on the lighting. The platforms, built in 1915, were some of the oldest areas of the station and had begun to scale away causing tripping hazards around the station.

Another problem was the old canopies. The parts of the station that were not under over-build were darkened by World War II blackout restrictions and all the canopies had been painted black. After awhile the lighting began to improve on a track-by-track project. We began to restrung high pressure sodium vapor 400 watt lights throughout the platforms. Little by little you could see your way around the station for the first time.

We pulled off one of the old canopies to take a look at the steel that was underneath it and found it was in fairly good condition. The passenger platforms had a different type of a canopy that had a curved arch design that was difficult to replicate.

Outside you could see the condition of the archways. Most of the sections were very heavily deteriorated. Most of the individual spans were corroded all the way through and, in fact, numerous panels had fallen in over the years. We stripped off the old frame and found that the main supporting arches were in good

condition. It was the internal spans that were the problem. We looked at a new method of replacing them which involved using continuous sheets of glass.

One by one we began to erect those sheets along the passenger canopies and you can see the effect it had. It opened them up to the light and was very economical. We were able to do this for about one-fifth of what it cost us in Philadelphia to do a similar platform canopy. You can see the effect it had downstairs. In fact the effect was so strong, areas underneath the overbuild were lit from the canopies over here.

We also started work on the old platforms. Not only did we have a problem with their age and the number of obstructions, they were not built to plate C standards. Instead of a standard five foot one inch from center line, they were built four foot nine inches. Some of our equipment could actually not clear into the station. The Santa Fe trains, for example, used to have to back in way at the very end of the platform and then wait because their engines could not clear the side of the platform. We wanted to eliminate that restriction and as the platforms were rebuilt they were reconfigured to the correct plate seat size arrangements.

We also began a reconstruction of the trackways in the station to replace the stub tie arrangement you see over here with a direct fixation network. They used embedded Pandrol clips directly into the concrete and a small hole arrangement that is very similar to that used on concrete ties. To do this we suspended the entire trackway eight inches above the slab and then poured the concrete all around it. We found this was an extremely efficient manner and cost about 10 percent less than replacing the stub tie arrangement that we had on the old platform.

Meanwhile at the end of the station stood the guardians of the station, the bumping posts built in 1916. Whoever built these things was scared to death that a train would enter the station. They have a 35 inch steel beam at the end of those bumping posts that is angled down through an eight foot by seven foot block of concrete directly into a pile cap bearing 160 feet into the ground into bedrock. (Laughter) There is no way you'll ever get a train into the station over those bumping blocks. You are not going to go through them. But the unfortunate problem is they are built fairly rigid and our

engineers in the operating department don't realize how far they have to go to these bumping posts. We have a lot of signs up but they don't always look at them. One by one over the years they have hit them. After a few passenger accidents and complaints and lawsuits and things like that, we took a look at another way. These are made in Germany. They are piston bumping posts. They can stop a ten car train doing about two to five miles an hour and bring it to a safe stop. They have an expansion fitting in the cylinder here and as the unit is compressed the amount of reaction increases dramatically as it goes toward the post. If it's going faster than that, the post will shear at this time providing an additional absorption of energy. It is felt that these things will reduce the hazard of the problem. These have been applied on all the tracks where we back into the station. We have yet to test them. They have been in for two years and no one has hit them so we don't know how well they will work. I have been told by the manufacturer that in England where they have less stringent operating rules, they have had a couple of drivers who hit them every other week as they come in. It's just their way of stopping the train. (Laughter) I don't know if I believe him or not but I don't want to see our people doing that. In fact I couldn't even get them to test them.

Along with the platforms themselves we also began work on other entrances to Union Station. Those entrances you saw are limited by our real estate ownings but they are not sufficient to handle the traffic entering the station. So with the not-so-easily-obtained cooperation of this owner we cut a hole in the front of his building and put in a series of stairways to the north platforms at the station. Because of predominance of the loop traffic being on the northern end of the loop we could get people into the station on the north sidewalk, down the platform directly on their trains without entering the station. This takes a lot of pressure off the station.

Another area we have been working on is the over-build projects. As I said earlier, back in the 1970s they were building over the station. They haven't stopped. We continue to sell air rights to the building which gives the engineering department no end of headaches.

We have two more sites left. One is at Lake and Canal Streets, where three buildings are

planned, and the other site is at Randolph and Lake and is currently under negotiation.

Along with that, another one of our over-build projects on the south is a completely different animal. We originally had been planning to put a repair car facility for our baggage cars in this location which is part of our mail terminal at the south end of the station. In the background you can see one of the world's largest post offices for the City of Chicago located over the air rights done in the 1930s. The post office bought the air rights for the whole block here and wants to put a building on it. Our control tower would be sitting up inside the building.

This is a closer view of our sheds. We pretty much gave up the idea of making mail terminal repairs in here because of the on-going construction. Everything on these two sides will be removed and we are going to try to span this whole area. The canopies that you see overhead all have to be removed and one by one we have to keep our baggage operations in service while they place columns down the middle of all these platforms.

Along with those over-build projects we are also working along with the City of Chicago. Each one of the viaducts over Union Station and there are 12 of them, have reached the end of their useful life. This one is most difficult. The other projects are pretty straight forward. We just work them out one by one as they go across the tracks. This is a two-level structure at Lake Street. The street is on this level. The CTA Rapid Transit is on this level. The columns don't intermatch, they are individually strung and downstairs here is the main throat for the north side of our station. We have spent countless meetings trying to figure out how in the world we are going to be able to take both of these down and keep the CTA and us in operation during it.

Another area we have been working on is intermodal programs with the City of Chicago. One of the main things is to provide interface stations for buses and light rail between the station. Currently we just have a few bus stops in front of the station. We're at the centerpoint of a number of transportation arteries in the City of Chicago with the expressway on this side and the rapid transit networks over on this side,

the river down the middle, and a variety of bus routes crossing in this area.

The canopy you see over Canal Street is a very small one that we currently have and does not provide much shelter in the rain. What we're looking at is a major change to Canal Street by working with funds from the City of Chicago, the State of Illinois, Amtrak and Union Station. It would involve building a new canopy along Canal Street, a transit island in the middle for buses with direct escalators to the station and a new entrance to the columnaded section along Union Station. The escalators would go directly into the station from this platform. This platform would also be built to handle the new light rail system that's being planned for the City of Chicago. This is a cross section showing the light rail operations, street traffic and traffic unloading at Union Station.

Along the Chicago River we are working with the operator of a commuter boat to install a new boat unloading operation right here which would allow us to have a dock for Union Station and to allow commuter passengers to exit directly to the commuter boats in the morning to travel upstream.

Also, there are two platform connections that would go out directly to the rapid transit network that has been abandoned since the late 1950s. We're looking at reactivating them and reusing them under another program.

The last item here is the Harrison/Lake interlocking. This project is just beginning and will be the subject of a future talk, I would hope. This involves the complete replacement of a double ladder interlocking at Harrison Street, Taylor Street and Roosevelt Road, all under traffic, along with a complete replacement of the signal and power board which runs that part of the station.

We have already begun to replace the rail in the station with new 132 pound welded rail and in many areas have installed concrete ties in areas of high curvature.

That pretty much concludes the talk. We have hopes for the future for the main waiting room which is shown in the artist's rendition in case the retail project is able to be completed. Maybe someday this will be the view of Union Station. Thank you very much. (Applause)

Mr. Nordlund: Thank you, Mark. The next special feature for this morning will be presented by Brian Zinck of CP Rail, on the subject "Tie Gang Simulation - Balancing Gang Costs Versus Service." Brian Zinck is director of industrial engineering for CP Rail. He received his education in Nova Scotia, Canada, and graduated with Bachelor of Science and Industrial Engineering degrees. For the first 10 years of his career he worked in the manufacturing and distribution operations of the International Nickel Company. In 1984 Brian joined CP Rail

and managed the industrial engineering program of implementing shop operating plans at the new Winnipeg Diesel Shop. In 1986 he was appointed director industrial engineering with system responsibility and a direct role in a number of field activities within engineering and maintenance-of-way. Just recently Brian was assigned to a research and operations improvement group covering all operating functions at CP Rail. Please welcome Brian Zinck. (Applause)

TIE GANG SIMULATION — BALANCING GANG COST VERSUS SERVICE

Brian Zinck

**Director of Industrial Engineering
CP Rail**

Thanks very much, Keith. Good morning ladies and gentlemen. I am honored to be present at the Roadmasters and B&B conference. This is my first time in St. Louis. It's been an excellent conference to date and I have certainly learned quite a bit on a very broad scope. I have enjoyed my stay in St. Louis and the hospitality of the people.

Before I start I would like to set up my presentation by reading an excerpt from our CP Rail News Digest made by Mr. William Stinson, chairman of CP Limited which is our parent company. I think it sort of ties in with what I am going to address so just bear with me.

Mr. Stinson says, "What we are trying to do at CP Rail, in particular, is position ourselves to take advantage of north/south trade flows. The interest in U. S. holdings was intensified by the passage of the free trade agreement between Canada and the U. S." Of course we heard quite a bit of detail about that yesterday. With the FTA in place it made sense to buy full control of the Soo Line and integrate its operations with that of CP Rail to give us one carrier service. We have since bought the Delaware and Hudson to gain access to the U. S. eastern seaboard. This was not a major acquisition, but is going to prove to be a strategically important one. And that is a critical word, strategic. We

now have access to Philadelphia, New York, Louisville and Kansas City. That particular strategy, of course, is one of acquisition for market growth. In order to be able to make that happen we have to have tactical tools or systems in place. Just by acquiring another railroad doesn't mean that you are actually going to get more growth, particularly with the Delaware and Hudson.

What I'm going to try to show you today is a tactical system that is presently under development. Computer simulation is one of the major tools that we have used to introduce a cost versus service sort of strategy.

We have a computer driven process here so you are going to actually see a live demonstration which is a computer simulation model of a tie operation. Before we actually go into the demo, I'll tell you a little bit of how computer simulation fits into our overall work program planning strategy. The title of the presentation, "Tie Gang Simulation—Balancing Cost Versus Service" is certainly a challenge that every railroad has to undertake.

Helping me with the presentation is Scott Tudor from CP Rail, who has worked a significant amount of time on the computer simulation model. Scott is going to drive the computer for me.

These are some comparative statistics showing Soo Line and CP Rail. The upper left hand corner is the route miles for the Soo Line, which is approximately 5,500, and 13,100 route miles for CP Rail. These are productivity indicators; 5.14 route miles for CP's maintenance-of-way employees and 3.109 for the Soo Line. I am going to go into the Soo Line with a little bit of detail with the actual demo. Millions of gross tons per maintenance-of-way employee, 34.2 on the Soo Line, 28 on CP Rail. Total 1990 maintenance-of-way spending, this is capital and expense dollars together, \$122 million approximately for the Soo and \$412 for CP Rail.

The presentation outline that I intend to follow today is a description of our work program planning system, our review of the computer simulation with an actual demonstration, and a brief summary at the end.

Work program planning system major components

One of the major components of the work planning system and the work program planning system I categorize as a sort of tactical productive support system. Standards is one component. Standards were developed for tie operations by doing field studies across Canada in 1987 and by looking at all our major tie gang operations under varying track conditions and varying time periods to give us a good cross section.

Gang modeling is, of course, using simulation and gives us an increased level of understanding between the interaction of significant variables that allows us to be able to look at predicting the output of a gang. This interaction of variables is very difficult when you are out on the track since days fluctuate and track conditions vary. Simulation is an excellent tool to do this and of course it's used heavily in manufacturing.

Master scheduling. The other major component of the work program planning support system is the sequencing of major programs like rail, ties, ballast, surfacing, undercutting, with a scheduling algorithm. That is presently under development. We feel we are about 80 percent complete with that particular module. I will not be going into that in any detail today. Primarily I'll be sticking to the simulation.

Management control is our feedback loop of

getting information back with respect to the plans and schedules that have been set up. Presently we have under development a micro-processor that would be put on key pieces of equipment that would report back on production and production time within the workblock to give us a significantly more accurate data base than we are presently receiving. There are actually some prototypes out there right now on CP Rail in Canada.

There are quite a few areas where we feel we can use a simulator. One, of course, is managing conflicts; two is setting schedules; three is evaluating change; four is training. There are many areas which we feel this tool is applicable in its use.

I'll go into more detail about managing conflicts. Train performance versus work block. This is, for instance, the amount of time transportation allows us to get on the track. I'm sure everyone is familiar with that. Transportation pretty much sets our work blocks.

Train performance versus gang productivity. How does that interfere with the size of the gang and the ability to be able to utilize the production we get out of it.

Scheduling conflicts. We have to use sidings and in a situation like this we have to be able to know which ones we can use and what impact that would have on the overall production of the gang in any given day or any given work block moving from one end of the territory or subdivision to another.

The simulator's role in setting schedules. We believe that with the simulator output we create more accurate output of a gang's capability which gives us the ability to set more realistic plans, and as I mentioned before, logistical considerations in being able to set more realistic plans, such as if material should arrive in the locations when needed as well as positioning our gangs so as not to interfere with train schedules. We want to understand the trade-off between service and cost.

Evaluating change. Programs. With respect to looking at changes in the program requirements, we would run programs of different sizes, 10, 20, 30,000 ties. We change how many ties we want to put in and we see what that really means in terms to the duration of programs, the cost of the programs. That's a simulator's capability.

Equipment changes. Changing a tie inserter

in a gang or changing a different piece of equipment in a gang and seeing what impact that would have over the work block and over the program. Different pieces of equipment have different production rates and different reliability rates and things like that. So we can evaluate those kinds of things. With a computer simulation model that has been set up reasonably well a lot of the field studies or demonstrations that we set up could be tested in advance and probably save us and the supply industry a lot of time.

Manpower. In that particular area we have an approximation of a learning curve effect within the model. This gives you the ability to see how an inexperienced operator would perform versus an experienced operator. We can use this in a number of ways to lead the gang roadmasters in the right direction to know what pieces of equipment they should concentrate on that are critical in the gang. It would tell them where they need the key trained people and the impacts of that.

Work block. Evaluating. We can basically run on the simulation model any variation of work blocks that we want to see what impact it would have on a particular gang size.

As I mentioned before, younger gang roadmasters can use the simulator to educate themselves in what key control variables really are significant variables and how they impact the production of the gang, whether it's track conditions, experience, individual pieces of equipment or reliability. It can educate them in being able to recognize why, at the end of the day, they get what they get, and if they make certain decisions during the shift what impact those decisions would have. They would also be able to project ahead and tell if the key operator or the operation is restricting the gang in a given day.

Engineering staff. In our unit offices we believe this will be an excellent front-end planning tool with respect to setting up appropriations.

This is a partial network map of the Soo Line. It's color coded. There is an orange area in the top left hand corner which is the Elbow Lake Subdivision. That's the subdivision which we'll be going into to look at a demonstration of a Soo Line tie gang.

This is the welcome screen to the CP Rail gang tie simulator. It's a PC based system that

is visually interactive. That's one of the key things with this. We wanted to make it user friendly, so that it could be taken, not only from people at my level, but right down through to the gang roadmaster. We're not there yet, but we built it with that intention. It's menu driven and is operated by a mouse or a function key. A mouse is a cursor that is a little arrow you set up on the screen. You just have to tap it to be able to go in and look at various tables and results and run your simulator.

This is the menu for the simulator. The first item is, of course, run simulation. The second item is the input specifications. Now let's go in and have a look at the input specifications. On the input specification menu we have subdivision specification tables, consist specification tables, and work block specification tables. These are various tables that we require to input into the actual running of the simulator. On the screen right now on the right hand side is the subdivision specification table. This can be pre-loaded for all the programs you have set up for the current year. As we scroll down the table, we should pick up the Elbow Lake subdivision. As you see, the arrow has gone in and selected Elbow Lake. Elbow Lake has been highlighted on the yellow screen on the right at the bottom. At the very top of the left hand screen the program requirements for Elbow Lake have been defined. The tie density is 770 ties per mile. We're going to put those 770 ties in 35 miles of track. The total program units is 26,950. We work out the tie density that's how we derive that. The production days required for this program was 36. The block hours that have been set there on this particular screen is six.

Timetable sidings locations. What we do for the program that was selected is to go in on Elbow Lake and pick the sidings that are within the proximity of Elbow Lake and define whether or not they are available based on train traffic. We can then open or close the sidings as we see fit and see what impact that would have on the production of the operation. We can save the information or we can edit or do anything we want. All these tables are pretty much editable where you can change things and go in and out.

Now let's look at specifications with respect to curved track. We would identify the starting mileage point and the length of the track. The importance there, of course, is with respect to

the spiking. When you are in curved track you increase your spikes per tie and that has an impact on your output at the end of the day. You can appreciate it if you are in heavy curved territory and you didn't have enough spikers. You certainly would see this with the simulation model as it ran. You would show your bottleneck, probably switching, from one of your operations to the other. This is helpful when you are setting up your operation to know what kind of impact that has, or to know what kind of impact that has if you have added more equipment and you don't have a lot of curved track. The question is, where are you going to make your savings? How are you going to make your savings without sacrificing train service and without sacrificing the quality of the job.

Now we'll exit from the screen and go to the consist specification tables. In the upper right hand corner there's a list of gangs which we have set up for CP Rail operations. They have been set up, like I said, from the studies that we've done in previous years.

Let's look at the Soo Line gang that we have set up. This is the sequencing of the equipment as it would appear on the track. From the top left hand part of the screen you can see the machine type, tie crane, dual spike pullers, extractors, scarifiers and inserters, all the way down to your spikers. This is a single gang on the Soo Line. It has a machine running number defined with it so that we can pull up certain other statistics on it. The operation is defined and has a value with respect to the piece of equipment for costing purposes.

Let's look at a little more detail on one specific machine. We pull up some information on a spiker. The yellow screen that just popped up is buffer sizes. What we have done with each piece of equipment is establish a minimum and maximum buffer between pieces of machinery. The minimum buffer is a safety factor between pieces of equipment, a safe operating distance. The maximum buffer is what you want to allow. If your operators space themselves out you can see what impact that will have at the end of the day in your production. That's the reason for the buffer zones. It gives us the ability to test sensitivity with respect to the spacing of operations.

Let's look at manpower. The manpower tables, like I said, were an approximation of a

learning curve in that we established a rating factor experience level with the operations that we studied in the field. We constructed what we felt was what impact that would have on production rate. It's an estimating tool that we developed during our studies.

The screen that just popped up is operator positions. This is the blow up of the labor component on the gang which gives us a costing component when we cost out the operation after we have run it. This is the labor cost component of the gang. From the manpower tables we develop a learning curve concept and then we go in and cost out what the gang is from a labor standpoint.

Let's go in and have a look at the equipment file and pull out the spiker again. In this particular table what's defined is the production rate of the piece of equipment. Production rates have been set up based on identifying key variables which we felt impacted the operation, whether it was density of ties, operator experience or some functional variable of the machine. Mean time between failures has been established as a reliability component and that's the amount of operating hours between failures on the equipment. That's installed on each piece of equipment so that we can have an idea of what impact changes of sensitivity and reliability mean within the gang. At present we have a merit information data base which is a machine repair history where we are pulling this information. Where we don't have that, we are going to default codes and, in the process, we can check sensitivity out regardless of what it is and see what it means. There is a mean time to repair which means the average hours it takes to repair a particular fault or breakdown.

We have looked at subdivision and consist input tables. Now we are going to look at work block input tables. On the purple screen we are going to run a simulation. This particular table shows 32 days and a work block on day one of six hours. We run that for four or five days and then we gradually decrease the work block with this particular gang down to three hours. We have actually gone down to two hours if we scroll down far enough. So we want to look at the impact of what work block variation will have on this particular size gang. We can put any combination of work blocks up there and run it. We can split the block in a given day, set up two or three hour blocks for instance or

whatever you want to do. It's unlimited. The clearance time that shows up on the green blocks on the lower left is the amount of time that it would take to close up the work in process.

We'll look at the costing input tables. What we've tried to do here is put together as close as possible a total costing component together for an operation that includes our appropriation system. We have materials cost which includes ties, spikes, rail anchors. This is the support labor costs above and beyond what is actually on the gang with respect to division forces, to mechanics, cooks, train crew. It's a more complete cost with respect to what is going on in the operation.

We will now go in and have a look at running the simulation. This is the simulation screen. Up above is the header information which is a repeat of what we saw in the subdivision tables. They give us the business unit, the subdivision, the program location, the program work units, the gang that we're using and the mileage point in view on the track. There are three levels of zoom on this simulation screen and we'll get into that in a little bit as we go along. Right in the center is the track and it runs right along there. The red dots are the defective ties. A clustering effect has been introduced into the model to simulate that condition as we would find it in the field. These were given to us by our track technology group. With 700 ties per mile you could have your ties spread out like it shows there, maybe one in ten or you could have three within six. It sort of simulates the effect of what's happening in the field.

The bottom section is a report section and it's showing unit labor cost. At this point in time there are three different types of reports: performance reporting, unit labor cost and machine status reporting. On the lower right hand corner are equipment states and I'll explain that before the simulation comes on. The individual pieces of equipment, as they move across the screen, will change color based on the state that they're in. The states are defined as working, moving, failed, front hold up and back hold up. The front and the back hold ups are the result of mismatched production rates in introducing a buffer zone between equipment which is, of course, these minimal and maximum allowances you want the equip-

ment to actually operate at or recognizing what that really means. It will go through those various color states as the pieces of equipment move through the screen. This is almost like a video game in that regard. It makes the whole part of planning, at least to me, a lot more fun.

As you see the equipment come across the screen you'll see it flash and it'll stop over the defective tie. This particular machine is a tie crane. It will be out in front of the actual operation putting the ties in close proximity to where they are going to be used from where they were dumped off by the section forces. This is the front end of the gang and it will continue to move across the screen. This scale is the largest scale in the simulator. It shows 40 ties in view.

This is 80 ties in view which means that you see 80 ties across the screen. It gives you more of the gang. So now we see a spike puller coming into the screen as well as the tie crane. Depending on how many machines there are in the gang, they'll do either alternate ties or whatever depending on what system of logic we want to set up, whether it's blocking out a section of ties or doing alternate ties. That's the end stage, 160 ties in view. It gives you a perspective of how the equipment is spaced out when you want to look at the level of zoom.

We can go to what we classify as the key machine we set up, the inserter.

As you can see, the equipment is going through various color states. As I said, the purple is back holdup. Green is moving. Yellow is working. We have a calendar up here at the top of the screen that shows that this is day 25, we're at one hour and 20 minutes into the work block, the mileage point of view is 184.70. If you're going to hit the plan that's set up on this model at one hour and 20 minutes into the work block, you really should be at 184.70.

I guess we should go into the reports section. We can continue to run the simulator. The first report on the screen is performance reporting and this is very difficult to pick up. That's one of the things we found out when we picked the colors. Blue and green don't show up very well. The function is defined on the left side: the running numbers down, the working percent. In other words, what utilization, how much is working. If it's 100 percent or if it's 60 percent so that we can identify where the bottleneck is in the operation. It shows the amount of time it's being held up by a machine in the front or

back. It shows the percentage of time that it's failed within the block and the rate per hour. In this particular case we've highlighted the scarifying machine because it's operating at about 100 percent and its rate is 224 ties per hour which is restricting this operation. That's the first performance report. It gives you a perspective of the utilization of your equipment. If you want to get into things like balancing off equipment, or recognizing which ones are important, which ones have a lot more capacity than other ones, you can certainly have a look at it.

This is a machine status report. Basically on the left hand side of the screen, it defines the function like tie distribution. It defines the running number, location of the machine, the exact specific location of where that machine is, whether it's moving to the siding, the starting time on the shift and the finish time on the shift. Here is where we determine our startup and shut-down losses on an operation and how long it takes to get started or should take to get started based on the constraints we have set up. Work in process is defined on the top left hand corner there. It shows that there are 179 ties in process on that gang. If we wanted to determine how much time was left to close up that gang we would look at taking the key machine and seeing what rate per hour it would work in the clearance time to the siding. We should know very closely how long it would take and not interfere with the trains.

Now this is a unit labor cost report and it's just labor at this point. But what we wanted to do here is show impact decreasing work blocks have on production and what impact that has on unit cost. For a six hour work block we are in the range of 1,200 ties at a cost of about six dollars per tie. As we go down through to a two hour work block we go down into the 300 ties per day at a \$24 unit labor tie cost. You can see the impact of what's happening to us as we lose block and if we can adjust the gang. Of course we've looked at adjusting the gang with that kind of tie cost. If it made sense then we could still complete the program. This is the kind of information that it's good to have a look at in advance and, of course, if you are sitting down with the service guys or the transportation guys, when we are looking at siding locations or what's available, just maybe, and depending on the trains that are moving through, we may have some slack time in the schedule. The abil-

ity to have a look at this or to have what I call a tactical tool to be able to look at what that really means, 15 minutes to us is a lot, sometimes in the schedule is a lot more than 15 minutes slack time. So this gives you a range of the costs on Elbo Lake with respect to running from a six hour block down to a two hour block with a respect to running from a six hour block down to a hour block with a single gang, single inserter.

This is again going back up to the main, the 40 time view screen. That's the scarifier coming across the track. We are in the process of developing a surfacing simulation model. We're setting up the logic for a ballast undercutting model. As I said before, this is one component within a work program planning system approach. It is a tactical support system for strategy that looks at maintaining our customer service and understanding the trade-offs which are critical between service and engineering costs. I think that there is one thing I learned and that is we have to link up functionally if we're going to succeed. This gives a better understanding of how we may be able to link up and get an understanding of costs versus service trade-offs. Thank you very much. (Applause)

Mr. Nordlund: Well, you have to hand it to Canadian Pacific. They brought a tie gang to this year's conference. It's certainly an insight into our future in maintenance-of-way to meet the challenges of the future, to be price competitive and provide that customer service. Thanks, Brian and Scott. It was an excellent presentation. If you have any questions, I'm sure they will be more than happy to talk to you afterwards. I'll now turn the podium over to Paul Saletnik.

Mr. Saletnik: Thank you, Keith. Since this year's conference commemorates the 100th year existence of the B&B Association many of the topics on the program have reflected back in history and traced the progress of technology to today. But what about the future? It is very fitting that the culminating address of this year's conference be entitled, "B&B: The Next 100 Years". The gentleman who will make that address is Mr. John Kapp, system engineer from Conrail.

John has been a member of our association since 1979. He was a director in 1980, 1981 and 1982; vice president in 1983 and he pre-

sided as president at our 1987 conference. John obtained his Bachelor of Science in civil engineering from Drexel University in 1968. He is a professional engineer in Pennsylvania and New York. John started with Conrail in 1978 as a

project engineer and is currently system engineer with the design and construction department. So to cap it all off, no pun intended, here is John Kapp with his insight for the future.

B&B IN THE NEXT 100 YEARS

John Kapp

System Engineer
Conrail



John Kapp

Thank you, Paul. Good morning. It is an honor for me to address the members of both Associations and their guests on this, the 100th Anniversary of the American Railway Bridge and Building Association. During the conference we have heard that the Bridge and Building Association was organized here in St. Louis on this exact date, 100 years ago. Thirty-six men attended that first meeting, headed by Owen J. Travis, superintendent of bridges and buildings and water supply for the Iowa Central Railway. He was elected as the Association's first president.

The first committee reports were presented at the Association's second meeting in 1892 and they included among others: Painting Iron Bridges; Framing and Protection of Howe Truss and Other Wooden Bridges Against Fire and Decay; Surface Cattle Guards.

In recent years the Association has sponsored reports not only on the building and

repair of railroad structures, but also on such topics as: Bridge and Culvert Replacement; Your Day in Court; Computerized Structure Management Systems; Protection and Testing of Underground Storage Tanks; Performance of Precast Concrete Ballast Deck Slabs; Roller Compacted Concrete.

Clearly, the maintenance and construction of our roads' facilities continue to be the primary focus of the Association, but legal issues and advance technology play a large part in today's agendas.

When President John Horney asked me to address the conference, he indicated that I had been chosen because he knew of no one better suited to speak on a subject that the speaker knew absolutely nothing about. In other words, he was telling me that my BS Degree was going to be put to good use.

But as a dutiful and responsible speaker, I sought to confer with others who might have some thoughts on the subject. I telephoned Fred Day and said, "Fred, you have been around most of the past 100 years. What do you see developing in the next 100 years." There was silence on the other end of the line. Maybe I should have phrased the question differently. (Laughter) Fred grumbled something about plastic bridges and hung up.

I know that no one person or group of people can predict the next 100 years. However, new products being developed today and on-going research can give us a glimpse of what is to come.

As some of our recent reports indicated, long range planning to avoid our day in court is becoming essential. Land development to hold existing customers and attract new business

now involves approvals from multiple government agencies. When wetlands are involved and off-site mitigation property is required, the process can and does take years. The on-the-ground employee needs to be knowledgeable in pollution clean-up and disposal when unearthing underground tanks and refurbishing buildings containing asbestos insulation or leaded pipe joints and paint.

Today, we see computer-aided drafting allowing one draftsman to do the work of many. New surveying computers allow one or two men to complete the work that used to be accomplished by a four man survey crew using a standard transit or level. Servo motors automatically level and aim the computer that measures distances and angles, records the information on a built-in memory or transfers the information to an extended memory that can then be transmitted directly to a CAD station for plotting. With the satellite technology that circles the globe being used for everything from locating and identifying car shipments to paging an individual, survey information will soon be plotted as it is being taken, giving the designer better, more reliable and quicker information.

Gridpads being used today on our railroads via a modem to transfer billing forms and time sheets to home offices are the beginning of pen-based computers that will decipher not only block printing but also cursive handwriting in the upcoming years.

Railroads, in an effort to encourage higher productivity, are involved with human engineering especially in today's computer-aided train dispatching facilities. Lighting and its reflection, positioning of screens, telephone headsets and touch screen computers all allow for a more attentive and reliable employee.

This attentiveness to the needs of people in the work place is becoming more important as illustrated by a recent article that showed 61 percent of the CEO's surveyed truly enjoy their work whereas only 20 percent of the middle managers and 19 percent of the lower-level workers in corporations truly enjoy their work. This finding agrees with what Mac Fleming told us on Monday about the unhappiness of our labor forces. The article goes on to state that corporations can boost morale and increase productivity by allowing employees to participate in the decisions that affect their life at

work. More employee participation to create new ideas that will allow us to work smarter, not harder, as Louis Alfeld noted on Monday, will become an essential part of our business allowing us to better serve our customers.

Newer building materials are being developed using a myriad of materials to preserve the structures of today and allow better construction of new facilities in the future. Aluminum powder is mixed with Portland cement, limestone, powdered silica sand and water to form a slurry that can be poured into greased molds. Rust protected steel reinforcing mats are then positioned into the molds before casting. The resulting product consists of millions of microscopic non-connected cells with the material being 80 to 90 percent air by volume, weighing only 19 to 62 pounds per cubic foot with a compressive strength of 800-1000 pounds per square inch. It is terminally efficient, fire resistant, frost and sulfate resistant and can be molded into a variety of shapes and sizes. The product can be easily handled due to its light weight with the corresponding lower transportation costs.

The mixture hardens enough in four hours to allow cutting and shaping. The shaped section is then held at an elevated temperature and pressure for up to 14 hours. This type of cellular concrete is being used throughout the world but does not have a manufacturing plant in this country. Researchers feel that once a plant is established, building construction in this country will become dominated by this material in the upcoming decades. The product can be easily sawn, drilled and nailed with ordinary woodworking tools making installation of plumbing, electrical conduits and the finishing of walls convenient.

All of these developments in the building industry are leading to a future when entire buildings can be shop fabricated, transported to the site, and quickly assembled. Buildings will be constructed in only days not months. Reuse of these building systems will allow maximum flexibility to relocate as business demands change as well as for conservation of material resources that will preserve the future of our planet.

The future is equally bright for bridge construction. The material that will evolve from today's concrete will have higher strengths with greater durability and flexibility. In February,

1989, the Center for Science and Technology of Advanced Cement-Based Materials was founded at Northwestern University. The Center is using electron microscopes to analyze tiny fractures in today's concrete. Concrete has always been tough and cheap but its main problems are a result of its porous structure. Tiny voids that are left behind when water chemically joins with cement can be the beginning of fractures caused by the freeze/thaw cycle and reinforcing steel corrosion.

In recent years, organic compounds called super plasticizers have reduced concrete's water content thus making the new product more homogeneous, intrinsically stronger and less prone to steel reinforcing corrosion. Through the addition of mineral compounds, concrete's compressive strength can be raised to 20,000 pounds per square inch. To provide greater flexibility to concrete and increase its tensile strength, long thin fibers of steel, glass and plastic that make up 10 to 20 percent of the concrete are being used to form an elastic matrix that prevents these cracks from enlarging.

Hybrid materials using polymers such as polyvinyl alcohol are being studied to create macro-defect-free cement. Artificial polymers allow for a material that is virtually pore free and can be extruded from mixing machines into precise shapes.

Fiberglass and epoxy resin roads are being used to form twisted cable that is used as a substitute for steel reinforcement in prestressing concrete to eliminate corrosion damage. The modules of elasticity for these cables is approximately one-third that of steel cables resulting in reduced loss of prestress due to shrinkage and creep. In 1986 the first post-tensioned two span bridge was constructed using fiberglass cables in Europe.

And in keeping with what Fred Day suggested, fiber-reinforced plastics composites which use polymer resins as a binder are being developed for use in bridges. Researchers have tested deck sections of these composites for strength and fatigue resistance. The fibers in these composites can be oriented in any direction to carry expected loads. Fiber reinforcements being used include glass, Kevlar and graphite.

Composite decks of these materials will be corrosion resistant and have the ability to be shop fabricated in modular units. Decks would

be 70 to 80 percent lighter than conventional concrete and could be quickly assembled in the field to reduce traffic disruption.

Today we realize that certain technological developments infringe on our environment and the quality of life. It will be up to us to analyze new products and use our intelligence to explore possible consequences and solutions. We must consider all the results of our work and show a regard and respect for nature.

Are we willing to pay higher initial costs for prolonged life? How much will industry invest to develop new products and equipment? The answers to these questions will tell us how fast these new advances will benefit our railroads.

With researchers testing 100,000 pounds per square inch concrete, microwave curing of building materials, composite bridge deck slabs, and longer high-strength steel spans, the need to create a master data base of all this information is essential. The information gained from computer-based models that allow designers to determine not only how materials will behave, but also aids in the selection of the correct type of equipment, would be fed into this data base allowing researchers and designers to share their gained knowledge instead of duplicating each other's work.

I know most of you came here today expecting to hear about 300 miles-per-hour bullet trains held on the rail through magnetic influence, of two major east-west railroads or of a major north-south rail link directly between Mexico, Central America and Canada with other lines feeding these major lines through direct computer train management, or of sensors on every bridge to determine deflection and strain. All of these would have been speculation on my part, but the fact does remain that in the future trains will still have to cross over rivers and gorges, and buildings will still be required, although possibly more below ground than above, to house railroad operations.

Fifty years ago, C. R. Knowles, a past president reviewed the first 50 years of the Association. In looking back over the Proceedings which comprise the work of this Association, Knowles said, "One cannot help but be impressed with the immense amount of work accomplished. There has been a remarkable advancement in railway structures during the last half century."

In his review, Mr. Knowles pointed out that

the Association's contact with manufacturers in the field has always been pleasant and harmonious. "This exchange of ideas between the members of this Association and the manufacturers has gone far toward the developments that have taken place in the materials, methods, and up-to-date equipment used in bridge and building work."

Mr. Knowles closed his 50 year review by saying "although we can well be proud of the work of the Association and the position it occupies in the railway field today, our work is not finished; it is hardly begun. Although

progress and development during our 50 years of existence have been remarkable, they are but little as compared with what we may expect in the future. The coming years promise even more and more progress, with which we must keep pace if we are to keep up with the procession of time." Mr. Knowles' words still ring true today. Thank you.

President Horney: Thank you very much, John. I knew I had found a perfect person to give that presentation when I talked to you. At this time I would like to ask Johnny Bradley to present the Resolution Committee Report.

RESOLUTION COMMITTEE REPORT

Having reached the closing of the annual joint conference of the American Railway Bridge and Building Association and the Roadmasters and Maintenance of Way Association of America and being deeply indebted to all those members and friends who have contributed their time and efforts to make our conference a success, it is right that we should acknowledge this indebtedness, and that it shall be so entered into the minutes of this meeting.

Be it further resolved, that our deep appreciation be extended to those who have honored our associations with their presence and by their informative addresses:

Stanley McLaughlin, vice president engineering, Union Pacific Railroad; David LeVan, senior vice president-corporate systems, Conrail; William Worthington, division of engineering and industry, Smithsonian Institution; Ernest Rewucki, president of the American Railway Engineering Association; Vin Terrill, president of Railway Engineering Maintenance Suppliers Association; Mac Fleming, president, BMWE; Tom Watts, vice president labor relations, Union Pacific Railroad; Louis Alfeld, Decision Dynamics; Dave Cook, Montana Rail Link; Dr. Allen Davis, STS Consultants; William Gilbert, Terminal Railroad Association of St. Louis; Robert McCann, Midwest Mobile Rail Service; Richard Lande, Lande and Associates; Bob Emmerich, Osmose; Julee Quarve-Peterson, JQP, Inc.; Don McCammon, Burlington Northern Railroad; Bob Gregory, CN Railway, Brian Zinck, CP Rail; Mark Walbrun, Amtrak; John Kapp,

Conrail, to all the committee chairmen and sponsors, who with the loyal cooperation of the committee members, prepared the interesting and instructive reports that have been presented, and to Wally Sturm, chairman of the B&B Association's 100th anniversary commemoration.

Be it further resolved that a very special thanks is expressed to Vin Terrill, president of REMSA, and to all members of the Railway Engineering Maintenance Suppliers Association for the fine reception and hospitality that we enjoyed during our conference. Our thanks are also expressed to Mrs. Teri Horney and Mrs. Pat Cossel and their committee members for their efforts in arranging registration and entertainment for our wives. A special thanks goes to Pat Weissmann and Barbara Marlow. Without their unselfish assistance, these two Associations would have great difficulty functioning.

And be it finally resolved that both Associations express their heartfelt thanks to our retiring presidents, John Horney and Jerry Cossel, who have spent so much time and effort in guiding the activities of our two Associations with great efficiency and dedication during the past year.

I move these resolutions be adopted.

Respectfully submitted,

/s/ Johnny Bradley
Chairman, Resolutions Committee

President Horney: Thank you, Johnny. At this time I would like to take the opportunity to present plaques to the outgoing directors in recognition of the excellent job they have done. I would like to call Tom Dunn and Mike Bradley to the podium. The plaque reads, "American Railway Bridge and Building Association presented for services as Director 1988-1991." Each plaque has the director's name on it. (Applause)

This year our treasurer has resigned and we would like to present him with a plaque and I would like Mark Walbrun to make that presentation. Mark.

Mr. Walbrun: Jim Williams was first elected to the board of directors of the B&B Association in 1978. He served until 1981. He became vice president in 1982 and president in 1985. He has been our treasurer since 1986. He served us through long and difficult years. For those of you who are unaware, ten years ago the B&B Association was in serious financial constraints. It was through Jim's help and guidance that we are the strong organization we are today and that we even made our 100th anniversary. My special thanks and deep-felt

gratitude to Jim for all his work. This plaque is presented to Jim Williams for all his efforts on behalf of the B&B Association. (Applause)

President Horney: Thank you. I'll now turn the podium over to Jerry Cossel.

President Cossel: Thank you, John. I would like to call our outgoing directors to the podium: Keith Nordlund, Al Butler and Carl Edwards. We are presenting plaques to these three gentlemen for their services as directors of the Association from 1987 to 1991. Each of these three have worked very diligently. I really feel that although I really didn't know two out of the three when they came onto the board, I have friends for life now. I also have a plaque for our outgoing treasurer, Gene Schubel. (Applause)

President Horney: I would like the immediate past president of the B&B Association, Byron Burns, to install the officers-elect of the American Railway Bridge and Building Association for 1991-1992, and Keith Pottorff, immediate past president of the Roadmasters and Maintenance of Way Association of America to install next year's Roadmasters' officers. Byron and Keith.

JOINT INSTALLATION OF OFFICERS

Mr. Burns: The following is the list of officers-elect of the American Railway Bridge and Building Association for the administrative year, 1991-1992. The officers so named please step forward and take a position in front of the podium. For president, Mark Walbrun, project manager, Amtrak, Chicago, Illinois; senior vice president, Paul Saletnik, engineer of buildings, Chicago and North Western Transportation Company, Chicago, Illinois; junior vice president, Don Steele, manager structure scheduling, Union Pacific, Omaha, Nebraska; junior vice president, John Van Huis, chief engineer planning and production, Wisconsin Central, Fond du Lac, Wisconsin; treasurer, Don Lewis, bridge construction engineer, Illinois Central, Chicago, Illinois. For directors with terms ending in 1994: Bob Carter, general B&B supervisor, Burlington Northern, Springfield, Missouri; Carl Young, project engineer, Conrail, Carlton, Michigan; Dave Franz, bridge engineer, Kansas City Southern, Kansas City, Missouri.

Mr. Pottorff: The following is the list of officers-elect of the Roadmasters and Maintenance of Way Association of America for the administrative year 1991-1992. The officers so named please step forward and take a position in front of the podium. For president, Stephen Hill, assistant division manager-engineering, Soo Line, Wood Dale, Illinois; first vice president, Ken Welch, chief engineer-planning and equipment, Union Pacific Railroad, Omaha, Nebraska; second vice president, Gene Schubel, division engineer, Burlington Northern Railroad, Springfield, Missouri; treasurer, Keith Nordlund, project manager, Canadian National. For directors with terms ending in 1995: Darrell Cantrell, director maintenance, Burlington Northern; Ken Johnson, assistant division engineer, CSX Transportation; Dave Kelly, vice president and chief engineer, Illinois Central, Chicago, Illinois.

Election to a position of leadership in any organization is an honor not to be taken lightly. Your fellow members, in electing each of you

to your respective office, have expressed confidence in you. First, that you are to discharge your several duties with distinction. Second, that you are willing to do so.

Mr. Burns: As the officers of our Associations, you will represent to the citizens of this country the true meaning of railway bridge and building and roadway maintenance and construction. You will be our collective voice in the industry. Thus, you will be our common bond with railway personnel throughout the United States and the world.

Mr. Pottorff: As the officers of our Associations you will represent our best interests in any of your activities or projects, always reminding yourselves that your attitude must be a part in any undertaking sanctioned by your respective Associations. In this you will be adhering strictly to the constitution and by-laws of our associations.

As a representative of the Roadmasters and Maintenance of Way Association of America I install each of you in the office to which you were elected in your Association.

Mr. Burns: As a representative of the American Railway Bridge and Building Association, I install each of you in the office to which you were elected in your Association. Please remain standing so that Mr. Pottorff and I may come down and congratulate you. The audience may now applaud. (Applause)

President Horney: At this time I would like to call on Vinnie Terrill, president of REMSA.

Mr. Terrill: Thank you, John. Presidents Hill and Walbrun, past presidents Horney and Cossel, members of the Roadmasters and Bridge and Building Associations, guests, ladies and gentlemen. On behalf of the Railway Engineering Maintenance Suppliers Association I wish to express our congratulations to both Associations on their selection of new officers and board members. What a great historic year it is for REMSA to follow tradition and to present the incoming presidents with engraved gavels symbolic of their authority especially during B&B's 101st year. This gavel may be used like a hammer handle to regain control when reason is not enough. President Stephen J. Hill of the Roadmasters and Maintenance of Way Association of America, please come up here and get your gavel, sir. Congratulations, Steve, the best wishes of REMSA for a productive year.

President Hill: Thank you, Vinnie.

Mr. Terrill: To president Mark C. Walbrun

of the American Railway Bridge and Building Association, when those B&B guys will no longer listen to your voice of reason and intelligence, you can catch their attention with this engraved weapon of authority during the 101st year of your organization. Congratulations, Mark, and the best wishes of REMSA go with this.

President Walbrun: Thank you.

Mr. Terrill: To acknowledge the immediate past presidents of the Roadmasters and Bridge and Building Associations it is a pleasure for me to present commemorative plaques to each of them. In doing so I want to express REMSA's congratulations for a most productive year and gratitude for the cooperative spirit you have shown in working with REMSA. Acting on behalf of REMSA's membership I am honored to present this plaque to Jerry Cossel for his service to the Roadmasters, 1990-1991. And my congratulations go to Pat also. (Applause)

John Horney, acting on behalf of the REMSA membership it is a pleasure to present this plaque commemorating your service to the Bridge and Building Association, 1990-1991. Please convey our best wishes and congratulations to Teri also. (Applause)

Thank you all for the honor you have given me to work with you in this most successful conference. (Applause)

Past President Horney: Well, this has been a challenging year. My mentors before me have set standards, goals and big foots to follow in. The Association this year has done things it has never attempted before. Only with the help and support of the executive board were these extra activities possible. In addition to what, in my opinion, I define as a successful conference this year, we have initiated and plan to continue to offer seminars, and we have offered extra functions focused around our 100 year anniversary.

As the out-going president, I would like to personally and publicly thank the executive board for their trust, support, and their own individual help that have made all these things possible and successful.

On a daily and hour-to-hour effort, none of us can match the work of our secretary, Pat Weissmann, and Barb Marlow at our lavish home office at Homewood, Illinois. Without their help and guidance I would have been lost. Thank you, Pat and Barb.

As I join the ranks of my mentors as a past president, I wish Mark and all the future presi-

dents the best. I also pledge my help when, or if, I am asked. I just ask all of you, the members, to help contribute when given the chance, whether to offer information for a presentation, to give a presentation, or to have the privilege to become a member of the executive board. I personally assure you, the experience will be on the positive side of your scale of life. Thank you. (Applause)

President Walbrun: Thank you, John. It is indeed an honor to stand here today. Twenty years ago I began my career at Amtrak, a company that was not expected to last for more than a few years. It has been a difficult job assisting in the reinvigoration of what was a moribund passenger industry. Today Amtrak has made important strides in many areas of railroad engineering. It stands at the brink of self-sufficiency in a country criss-crossed by many other subsidized modes of transportation.

As I look back at the last 100 years of progress in the Bridge and Building Association I am grateful for the chance to have contributed to its mission. As we begin our next century of B&B engineering we stand at the shoulders of those before us. Doing so we may remark how far it is we have come and then we turn around and see how far it is we truly have to go.

Thank you and I appreciate your confidence. I am looking forward to seeing you all in Chicago next year and please, fill out the orange form in the back of the room on your way out. Thank you. (Applause)

President Cossel: I didn't write any speech, at least a going away speech, but about five minutes ago when Vinnie Terrill said, "past presidents Cossel and Horney" it made me feel like a has-been. I would very much like to thank the executive committee of the Roadmasters for their cooperation this past year. It has been a truly enjoyable seven or eight years. I would like to thank Barbara Marlow, and jointly, Pat, the two Pats, Pat Weissmann and my wife, Pat, for enduring me this past year. Thank you very much. (Applause)

I would like to introduce Steve Hill, the new president of the Roadmasters Association. I would also like to present him with the president's pin for the the year 1991-1992.

President Hill: Thank you, Jerry. At the

reception last night, Jerry, Vinnie and I were discussing how long this remarks speech should be. Jerry kept telling me that "once Vinnie gets going it could take 20 minutes." But since Jerry was so brief I will emulate that. In 1978 I was working for the IC and the division engineer came into the office and handed me an application and gave me a clear understanding I was to fill it out and send it in. That got me started with this organization. Looking back on it I want to thank Doug DeBerg for making that effort to get me involved. It's meant a lot to me over the years to be a part of this organization and I look forward to a good year ahead working with the board members who are continuing and the new ones coming onboard, developing more along our mission statement line.

I would like to thank Vinnie Terrill and REMSA for all their support. Of course there is Pat and Barb, without who we would very soon cease to function properly. They may question whether we function properly now anyway. (Laughter)

I don't have any other profound statements to make. I have a plaque to present to Jerry Cossel. It's an appreciation award presented by the Roadmasters and Maintenance of Way Association of America to Jerome D. Cossel for his services as president 1990-1991.

Past President Cossel: Thank you. (Applause)

President Hill: Mark has a presentation to make also.

President Walbrun: Thank you, Steve. I look forward to working together over the next year.

John, this has been a tremendous year. The B&B Association has made some gigantic progress in many areas, including particularly the education seminars which were spurred on by yourself. I must say these are very big shoes indeed to fill. John, thank you. (Applause)

President Hill: There being no further business to be presented at this conference, I hereby declare the 103rd annual conference of the Roadmasters and Maintenance of Way Association of America and the 96th annual conference of the American Railway Bridge and Building Association adjourned.

Adjourn



Left to right: M. C. Walbrun, P. H. Saletnik, D. J. Lewis, R. W. Carter, D. K. Franz



Seated: M. C. Walbrun, P. A. Weissmann, J. J. Horney, P. H. Saletnik
Standing, Left to right: D. F. Sorgenfrei, B. T. Burns, R. W. Carter, D. G. DeBerg,
 D. L. McCammon, J. A. Lileikis, J. T. Creighton, T. V. Dunn, M. L. Bradley, J. M. Williams,
 J. G. Bradley

HISTORY OF THE ASSOCIATION

On June 25, 1891, Owen J. Travis, superintendent of bridges and buildings and water supply of the Iowa Central Railway, addressed a letter to officers of railroad departments across the country asking their views about the feasibility of organizing a national association. There were nearly 100 responses to his letter and, with one exception, all were favorable to the concept. From recommendations in those responses, St. Louis was the site selected for the first meeting of the Association on September 25, 1891.

Accordingly, on September 25, 1891, 36 men representing the bridge and building departments of their respective railroads met for the first time in the office of R. W. Green of the St. Louis Car Wheel Company in the Bank of Commerce Building. The Association was organized as the American International Association of Railway Superintendents of Bridges and Buildings. These 36 men, along with 24 others who were unable to attend, represented 40 railroads and became the charter members of the Association.

The Association is indebted to the family of the first Secretary, C. W. Gooch, for the collection of original letters saved by Mr. Gooch pertaining to the Association. These include the original letter sent by Owen Travis concerning the feasibility of forming the Association, Mr. Gooch's reply, an announcement of the first meeting, the hand-written first report by the secretary of the Association's financial condition after its initial year, and an article about the Association's organization that appeared in the Des Moines Register on September 26, 1891. Mr. Gooch was the last surviving charter member of the Association and passed away on September 20, 1948. The collection of letters were found in the home of his son James. These letters were donated to the Association through the courtesy of Mr. Gooch's grandson and great-granddaughter. They were displayed during the 100th anniversary observance at the 1991 conference in St. Louis.



Owen J. Travis



Charles W. Gooch

Throughout its history, the Association has been fortunate to have had dedicated individuals who have served as officers and directors, many of whom have served in other capacities when their terms of office expired. This action provides a continuity that has helped the Association prosper.

Many dramatic changes have occurred during the 100 years of the Association's existence but the basic reasons for forming the Association still exist. The need to exchange information and to find solutions to the problems that confront the railroad engineering profession are as important today as they were in 1891. With ever changing technology, the Association is a necessary element in the advancement of knowledge for all who are engaged in the process of designing, constructing and maintaining railroad buildings, bridges and related facilities. It will be the responsibility of the members to carry on the tradition that has been passed on to them.

MEMORIES OF THE FIRST MEETING

First Secretary, C. W. Gooch, gave this account of the 1891 meeting in an article in the February, 1923, Bulletin of the Association:

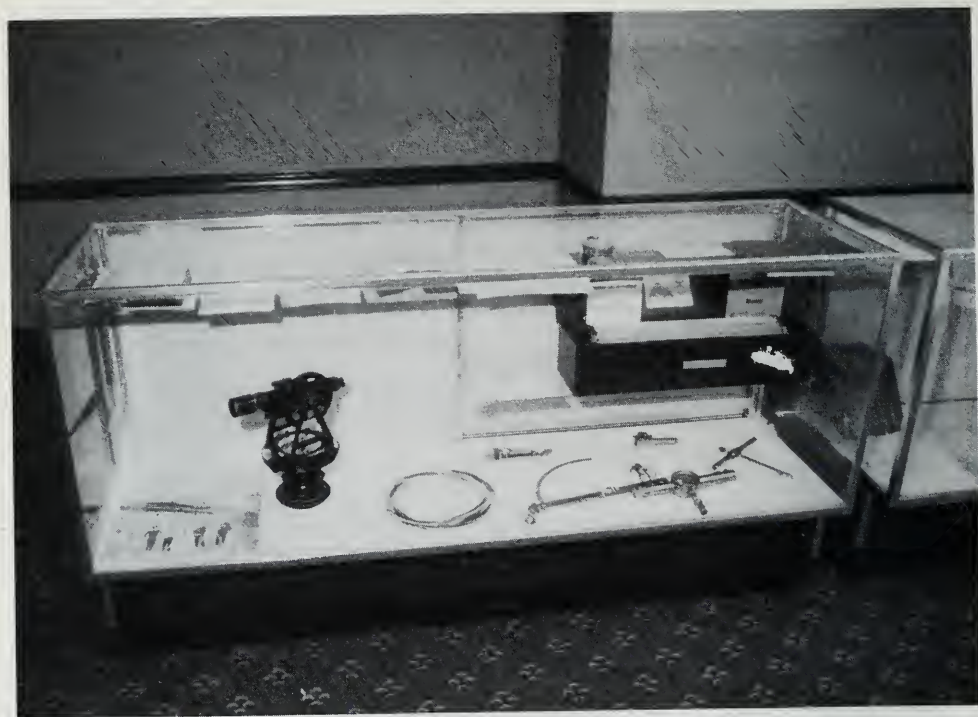
"I left Des Moines for St. Louis the day before that set for the meeting. By previous arrangement, Mr. James Stannard and I were to meet at six o'clock at the Silver Moon (a place noted for "eats" in those days). After satisfying our appetites we started toward the Southern Hotel, figuring to reach there a short time before Mr. Travis would arrive. While waiting in the office we were confronted with the thought as to how we would know him, as neither had even a description of him. We figured he would be a person fidgety and excited, would scan the register for names and then sign up.

We had been there but a short time when here came our man and as we moved up close we caught by the twist of the pen that O. J. Travis had registered. As he turned from the desk I spoke to him, introducing myself, and his first words, were, "Gooch, is there anybody else here?" I answered by introducing James Stannard of the Wabash. The next was W. R. Damon of the Louisville, Nashville & St. Louis, and by that time it seemed as though everybody was a bridge man, for no less than 15 had gathered around waiting for something to start, and at once there was living evidence that the "Bridge Meet" was on. We then repaired to the north entrance of the hotel and sat around in small groups in a general get-acquainted way.

In a few minutes another man appeared who was recognized by someone in the crowd and was duly introduced to Mr. Travis. His first words were, "Mr. Travis, why on earth did you select the 25th for our meeting and organization, because it comes on Friday and is a 'Jonah' across our bow to begin with?" After a hurried exchange of ideas a man who had arrived early in the evening spoke up, saying he had been assigned an unusually large room, and suggested we go there, read the articles of Constitution and By-Laws, adopt them and have everything clear for the coming morning. The invitation was accepted and thus the "Friday" voodoo was disposed of, and if there is anything to it, our present prosperous condition indicates it was a wise precaution.

We met the following morning, as had been planned, and everything proceeded smoothly and in regular order until it came time to make up the roster and pay the dues. We were at a loss as to how to proceed when George M. Reid of the Lake Shore and Michigan Southern Railway came forward and said, 'Gentlemen, we have all heard the Constitution and By-laws, therefore, let every man examine himself as to eligibility for membership, instruct the secretary to enroll his name and part with his money.' It was easy to get in then. After this ceremony we were a full-fledged and paid-up organization with \$145 in the treasury. The meeting adjourned at six o'clock sine die, to meet again at Cincinnati, Ohio, on the second Tuesday in October in 1892."







Past Officers

	1891-1892	1892-1893	1893-1894	1894-1895
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews
1st V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle
2nd V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford
3rd V.-Pres.	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard
4th V.-Pres.	G. W. Hinman	C. T. Fuller	E. D. Hines	Walter G. Berg
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid
Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin
	C. W. McGehee	Q. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

	1895-1896	1896-1897	1897-1898	1898-1899
President	W. A. McGonagle	James Stannard	Walter G. Berg	J. M. Cummin
1st V.-Pres.	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley
2nd V.-Pres.	James Stannard	J. H. Cummin	A. S. Markley	C. C. Mallard
3rd V.-Pres.	Walter G. Berg	A. S. Markley	G. W. Hinman	W. A. Rogers
4th V.-Pres.	J. H. Cummin	R. M. Peck	C. C. Mallard	J. M. Staten
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes
	L. J. White	W. M. Noon	C. P. Austin	J. H. Markley
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman

	1899-1900	1900-1901	1901-1902	1902-1903
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres.	J. M. Staten	B. G. Pickering	A. Shane	A. Shane
3rd V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith
	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W. O. Eggleston	J. H. Markley

	1903-1904	1904-1905	1905-1906	1906-1907
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
2nd V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty
3rd V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	W. O. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Schetz	G. Aldrich
	C. W. Richey	F. B. Schetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullen	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
Executive Members	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	F. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
Executive Members	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
Directors	A. B. McVay	A. B. McVay	J. H. Johnson	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Johnston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

	1923-1924	1924-1925	1925-1926	1926-1927
President	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres.	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres.	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres.	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres.	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
Directors	P. N. Nelson	E. L. Sinclair	P. N. Nelson	P. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres.	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres.	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres.	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres.	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise		
	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
Directors	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

PAST OFFICERS

	1934-1935	1935-1936	1936-1937	1937-1938
President	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres.	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres.	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres.	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres.	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
Directors	L. C. Smith	F. H. Cramer	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCloy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938-1939	1939-1940	1940-1941	1941-1942
President	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres.	F. H. Cramer	F. H. Cramer	F. E. Dove	F. H. Soothill
2nd V.-Pres.	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres.	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres.	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.	C. A. Lichty	C. A. Lichty		
Secretary			F. O. Whiteman	A. G. Shaver
Treasurer			F. E. Weise	F. E. Weise
	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
Directors	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

	1942-1943	1943-1944	1944-1945	1945-1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
	F. E. Weise			
Treasurer		C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
		W. F. Martens	W. F. Martens	A. B. Chapman
Directors	M. Meyer	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	L. E. Peyser	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	K. L. Miner	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	F. G. Campbell	A. B. Chapman	A. B. Chapman	B. R. Meyers
	J. S. Hancock	L. E. Peyser	L. E. Peyser	L. E. Peyser
	L. C. Winkelhaus			

† To November 1, 1942 ‡ To February 1, 1943

	1946-1947	1947-1948	1948-1949	1949-1950
President	F. G. Campbell	J. S. Hancock	E. H. Barnhart	W. F. Martens
1st V.-Pres.	J. S. Hancock	E. H. Barnhart	W. F. Martens	W. A. Huckstep
2nd V.-Pres.	E. H. Barnhart	W. F. Martens	W. A. Huckstep	Guy E. Martin
3rd V.-Pres.	W. F. Martens	W. A. Huckstep	Guy E. Martin	F. R. Spofford
4th V.-Pres.	W. A. Huckstep	G. E. Martin	F. R. Spofford	Lee Mayfield
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	C. R. Knowles	C. R. Knowles	L. C. Winkelhaus	L. C. Winkelhaus
	Guy E. Martin	H. M. Harlow	Lee Mayfield	H. M. Harlow
Directors	B. R. Meyers	H. B. Christianson	F. M. Misch	V. E. Engman
	L. E. Peyser	F. R. Spofford	W. D. Gibson	G. W. Benson
	H. M. Harlow	Lee Mayfield	H. M. Harlow	F. M. Misch
	H. B. Christianson	Franz M. Misch	V. E. Engman	L. R. Morgan
	F. R. Spofford	W. D. Gibson	G. W. Benson	A. J. Jorlett

	1950-1951	1951-1952	1952-1953	1953-1954
President	W. A. Huckstep	Guy E. Martin	F. R. Spofford	Lee Mayfield
1st V.-Pres.	Guy E. Martin	F. R. Spofford	Lee Mayfield	H. M. Harlow
2nd V.-Pres.	F. R. Spofford	Lee Mayfield	H. M. Harlow	A. J. Jorlett
3rd V.-Pres.	Lee Mayfield	H. M. Harlow	A. J. Jorlett	R. R. Gunderson
4th V.-Pres.	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
	F. M. Misch	M. H. Dick	W. H. Huffman	M. H. Dick
Directors	L. R. Morgan	R. R. Gunderson	L. R. Morgan	J. F. Warrenfels
	J. A. Jorlett	J. F. Warrenfels	B. M. Stephens	G. Switzer
	M. H. Dick	W. H. Huffman	M. H. Dick	B. M. Stephens
	R. R. Gunderson	L. R. Morgan	J. F. Warrenfels	W. H. Bunge
	J. F. Warrenfels	B. M. Stephens	G. Switzer	E. R. Schlaf

PAST OFFICERS

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	1954-1955	1955-1956	1956-1957	1957-1958
President	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
1st V.-Pres.	J. A. Jorlett	R. R. Gunderson	W. H. Huffman	M. H. Dick
2nd V.-Pres.	R. R. Gunderson	W. H. Huffman	M. H. Dick	B. M. Stephens
3rd V.-Pres.	W. H. Huffman	M. H. Dick	B. M. Stephens	H. D. Curie
4th V.-Pres.	M. H. Dick	B. M. Stephens	H. D. Curie	
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
	B. M. Stephens	J. F. Warrenfells	W. H. Bunge	G. W. Benson
Directors	W. H. Bunge	H. D. Curie	E. R. Schlaf	J. M. Lowry
	E. R. Schlaf	J. M. Lowry	G. W. Benson	H. H. Matthews
	J. F. Warrenfells	W. H. Bunge	J. M. Lowry	T. M. VonSprecken
	H. D. Curie	E. R. Schlaf	T. M. VonSprecken	W. H. Bunge
	J. M. Lowry	G. W. Benson	H. A. Matthews	E. R. Schlaf

	1958-1959	1959-1960	1960-1961	1961-1962
President	M. H. Dick	B. M. Stephens	H. D. Curie	G. W. Benson
1st V.-Pres.	B. M. Stephens	H. D. Curie	G. W. Benson	J. M. Lowry
2nd V.-Pres.	H. D. Curie	G. W. Benson	J. M. Lowry	E. R. Schlaf
3rd V.-Pres.	G. W. Benson	J. M. Lowry	E. R. Schlaf	H. A. Matthews
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
	J. M. Lowry	W. H. Bunge	H. A. Matthews	R. C. Baker
Directors	R. C. Baker	E. R. Schlaf	M. J. Hubbard	R. H. Miller
	W. H. Bunge	H. A. Matthews	Shirley White	Shirley White
	E. R. Schlaf	M. J. Hubbard	R. H. Miller	H. M. Wilson
	H. A. Matthews	R. C. Baker	Shirley White	R. D. Hellweg
	M. J. Hubbard	R. H. Miller	H. M. Wilson	F. W. Hutcheson

	1962-1963	1963-1964	1964-1965	1965-1966
President	J. M. Lowry	E. R. Schlaf	R. C. Baker	H. M. Wilson
1st V.-Pres.	E. R. Schlaf	R. C. Baker	H. M. Wilson	R. D. Hellweg
2nd V.-Pres.	H. A. Matthews	Shirley White	R. D. Hellweg	J. W. DeValle
3rd V.-Pres.	R. C. Baker	H. M. Wilson	J. W. DeValle	W. F. Armstrong
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	E. F. Snyder	E. F. Snyder	E. F. Snyder
	Shirley White	R. D. Hellweg	W. F. Armstrong	J. A. Goforth
Directors	H. M. Wilson	F. W. Hutcheson	J. S. Ellis	E. R. Simmons
	R. D. Hellweg	W. F. Armstrong	J. A. Goforth	N. D. Bryant
	F. W. Hutcheson	J. W. DeValle	E. R. Simmons	A. R. Dahlberg
	W. F. Armstrong	J. A. Goforth	N. D. Bryant	J. S. Ellis
	J. W. DeValle	E. R. Simmons	A. R. Dahlberg	T. L. Fuller

	1966-1967	1967-1968	1968-1969	1969-1970
President	R. D. Hellweg	J. W. DeValle	W. F. Armstrong	J. A. Goforth
1st V.-Pres.	J. W. DeValle	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg
2nd V.-Pres.	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg	T. L. Fuller
3rd V.-Pres.	J. A. Goforth	A. R. Dahlberg	T. L. Fuller	N. D. Bryant
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
	N. D. Bryant	J. S. Ellis	N. F. Lucas	W. H. Rankin
Directors	A. R. Dahlberg	T. L. Fuller	W. L. Short	E. E. Runde
	H. F. Lucas	R. A. Youngblood	C. E. Wachter	T. A. Reynolds
	J. S. Ellis	H. F. Lucas	A. C. Jones	J. J. Ridgeway
	T. L. Fuller	W. L. Short	W. H. Rankin	J. R. Williams
	R. A. Youngblood	C. E. Wachter	E. E. Runde	J. W. Chambers
	V. D. Raessler	A. C. Jones	T. A. Reynolds	R. E. Frame
	W. L. Short	W. H. Rankin	J. J. Ridgeway	J. C. Hobbs
	C. E. Wachter	E. E. Runde	J. R. Williams	

	1970-1971	1971-1972	1972-1973	1973-1974
President	A. R. Dahlberg	T. L. Fuller	N. D. Bryant	E. E. Runde
1st V.-Pres.	T. L. Fuller	N. D. Bryant	E. E. Runde	J. J. Ridgeway
2nd V.-Pres.	N. D. Bryant	E. E. Runde	J. J. Ridgeway	J. R. Williams
3rd V.-Pres.	E. E. Runde	J. J. Ridgeway	J. R. Williams	W. R. Rankin
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
	T. A. Reynolds	R. K. Corbett	R. K. Corbett	D. C. Gould
Directors	J. J. Ridgeway	R. E. Frame	J. R. Iwinski	W. S. Stokely
	J. R. Williams	J. C. Hobbs	J. S. Pritchett	W. C. Sturm
	J. W. Chambers	R. K. Corbett	D. C. Gould	J. W. Davidson
	R. E. Frame	J. R. Iwinski	W. S. Stokely	C. A. Hughes
	R. C. Hobbs	J. S. Pritchett	W. C. Sturm	W. R. Hyma
	R. K. Corbett	D. C. Gould	J. W. Davidson	O. C. Denz
	J. R. Iwinski	W. S. Stokely	C. A. Hughes	R. C. McMaster
	J. S. Pritchett	W. C. Sturm	W. R. Hyma	W. E. Brakensiek

PAST OFFICERS

	1974-1975	1975-1976	1976-1977	1977-1978
President	J. J. Ridgeway	J. R. Williams	W. H. Rankin	J. R. Iwinski
1st V.-Pres.	J. R. Williams	W. H. Rankin	J. R. Iwinski	W. C. Sturm
2nd V.-Pres.	W. H. Rankin	J. C. Hobbs	W. C. Sturm	D. C. Gould
3rd V.-Pres.	J. C. Hobbs	J. R. Iwinski	D. C. Gould	J. W. Chambers
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	J. W. Davidson	W. E. Brakensick	W. J. Gunkle	W. J. Gunkle
	C. A. Hughes	O. C. Denz	M. Noyszewski	W. E. Halley
	W. R. Hyma	R. C. McMaster	W. J. Gunkle	K. L. Wammell
	W. E. Brakensick	F. R. Lindsay	W. E. Halley	J. Budzileni
	O. C. Denz	M. Noyszewski	K. L. Wammell	B. J. King
	R. C. McMaster	W. C. Sturm	J. Budzileni	J. G. Robertson
	F. B. Lindsay, Jr.	W. J. Gunkle	B. J. King	O. C. Denz
	M. Noyszewski	W. E. Halley	J. G. Robertson	E. C. Patterson
	Jim Payne	K. L. Wammell		W. S. Stokely

	1978-1979	1979-1980	1980-1981	1981-1982
President	W. C. Sturm	D. C. Gould	J. W. Chambers	W. R. Hyma
Sr. V.-Pres.	D. C. Gould	J. W. Chambers	R. C. McMaster	O. C. Denz
Jr. V.-Pres.	J. W. Chambers	R. C. McMaster	W. R. Hyma	J. Budzileni
Jr. V.-Pres.	R. C. McMaster	W. R. Hyma	O. C. Denz	J. M. Williams
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Pat Weissmann
Treasurer	W. F. Armstrong	W. F. Armstrong	W. F. Armstrong	W. C. Sturm
Directors	J. Budzileni	O. C. Denz	J. W. Davidson	D. A. Bessey
	B. J. King	W. J. Gunkle	C. M. Russell	J. N. Michel
	J. G. Robertson	W. S. Stokely	J. M. Williams	P. H. Saletnik
	O. C. Denz	L. D. Green	D. A. Bessey	O. D. Anthony
	E. C. Patterson	C. M. Russell	J. N. Michel	J. T. Kapp
	W. S. Stokely	J. M. Williams	P. H. Saletnik	D. J. Lewis
	L. D. Green	D. A. Bessey	D. O. Anthony	J. W. Davidson
	C. M. Russell	J. N. Michel	J. T. Kapp	H. J. Laga
	J. M. Williams	P. H. Saletnik	D. J. Lewis	A. S. Uppal

	1982-1983	1983-1984	1984-1985	1985-1986
President	O. C. Denz	J. Budzileni	J. M. Williams	D. A. Bessey
Sr. Vice President	J. Budzileni	J. M. Williams	D. A. Bessey	J. T. Kapp
Jr. Vice President	J. M. Williams	D. A. Bessey	J. T. Kapp	D. J. Lewis
Jr. Vice President	D. A. Bessey	J. T. Kapp	D. J. Lewis	R. A. Tallent
Secretary	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann
Treasurer	P. H. Saletnik	P. H. Saletnik	P. H. Saletnik	J. M. Williams
Directors	O. D. Anthony	J. W. Davidson	T. E. Kuhn	B. T. Burns
	J. T. Kapp	D. J. Lewis	D. R. Ladner	J. J. Horney
	D. J. Lewis	T. E. Kuhn	R. A. Tallent	W. J. Semoli
	J. W. Davidson	D. R. Ladner	B. T. Burns	R. E. Fronczak
	H. J. Laga	R. A. Tallent	J. J. Horney	W. P. Cunningham
	A. S. Uppal	B. T. Burns	W. J. Semoli	J. H. Smith
	T. E. Kuhn	J. J. Horney	D. W. Brookings	E. Bond
	D. R. Ladner	W. J. Semoli	W. P. Cunningham	D. L. Steele
	R. A. Tallent		J. H. Smith	M. C. Walbrun

	1986-1987	1987-1988	1988-1989	1989-1990
President	J. T. Kapp	D. J. Lewis	R. A. Tallent	B. T. Burns
Sr. Vice President	D. J. Lewis	R. A. Tallent	B. T. Burns	J. J. Horney
Jr. Vice President	R. A. Tallent	B. T. Burns	J. J. Horney	M. C. Walbrun
Jr. Vice President	B. T. Burns	J. J. Horney	M. C. Walbrun	P. H. Saletnik
Secretary	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann
Treasurer	J. M. Williams	J. M. Williams	J. M. Williams	J. M. Williams
Directors	W. H. Nelson	M. C. Walbrun	C. E. Thompson	W. H. Nelson
	J. H. Smith	S. Lipkus	H. L. Davidson	T. J. Parker
	J. J. Horney	D. L. Steele	J. A. VanHuis	R. C. Karsten
	M. C. Walbrun	C. E. Thompson	W. H. Nelson	R. C. Carter
	E. Bond	H. L. Davidson	T. J. Parker	T. V. Dunn
	D. L. Steele	J. A. VanHuis	R. C. Karsten	M. L. Bradley
	C. E. Thompson	W. H. Nelson	S. Lipkus	D. G. DeBerg
	H. L. Davidson	T. J. Parker	T. V. Dunn	D. F. Sorgenfrei
	J. A. VanHuis	R. C. Karsten	M. L. Bradley	J. A. Lileikis

	1990-1991	1991-1992
President	J. J. Horney	M. C. Walbrun
Sr. Vice President	M. C. Walbrun	P. H. Saletnik
Jr. Vice President	P. H. Saletnik	D. L. Steele
Jr. Vice President	W. H. Nelson	J. A. Van Huis
Secretary	P. A. Weissmann	P. A. Weissmann
Treasurer	J. M. Williams	D. J. Lewis
Directors	R. C. Carter	D. G. DeBerg
	T. V. Dunn	D. F. Sorgenfrei
	M. L. Bradley	J. A. Lileikis
	D. G. DeBerg	D. L. McCammon
	D. F. Sorgenfrei	J. T. Creighton
	J. A. Lileikis	J. G. Bradley
	D. L. McCammon	R. W. Carter
	J. T. Creighton	C. W. Young
	J. G. Bradley	D. K. Franz

CONSTITUTION

(Revised September 18, 1990)

ARTICLE I

NAME

Section 1. This Association shall be known as the American Railway Bridge and Building Association.

ARTICLE II

OBJECT

Section 1. The object of this Association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway structures and fixed facilities by investigation, reports and discussions.

Section 2. The Association shall neither endorse nor recommend any particular devices, trademarks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussion unless the same have received the endorsement of the Association in regular session.

ARTICLE III

MEMBERSHIP

Section 1. The membership of this Association shall be divided into five classes: Members, Life members, Associate members, Honorary members and Junior members.

Section 2. A member shall be a person in the railway industry (except representatives of manufacturers and/or suppliers of equipment, material or labor services, or individuals who are subject to collective bargaining) engaged in engineering, construction and maintenance of railway structures and fixed facilities; a person in the employ of a public regulatory body; a professor of engineering or architecture; a technical editor; a materials expert; a consulting engineer, or an engineer employed by a consulting engineering firm, engaged in the engineering, construction and maintenance of railway-related facilities; an engineer employed by a technical service or research and development organization; or an officer or engineer of an engineering or scientific society or association whose aims and objectives are compatible with the aims and objectives of this Association. Any person desirous of becoming a member shall make application upon the form prescribed by the Executive Committee, setting forth the applicant's name, address and practical experience. The applicant shall be recommended by at least one member of the Association to whom they are personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the Executive Committee, a majority vote being necessary in either instance.

Section 3. To be eligible for a life membership, an individual must have belonged to the Association for at least 15 years and in general must have retired from active employment due to age or physical disability. A life member shall have all the privileges of previous membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2 of this Article.

Section 4. Associate members shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to cooperate with members in the study and development of improved practices in the construction and maintenance of railway structures and fixed facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2 of this Article, except that they shall be recommended by either a member or an associate member of the Association to whom they are personally known.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the majority vote of the members present at a regular meeting. They shall have all the rights of members except that of holding office and shall be exempt from the payment of dues.

Section 6. Any person in the Association membership whose conduct in any way diminishes the professionalism or prestige of the Association, or who shall refuse to comply with the rules of this Association, shall forfeit membership in the Association on a two-thirds vote of the Executive Committee.

Section 7. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 8. Only members shall hold office in this Association, and only members and qualified life members shall be entitled to vote in the election of officers.

Section 9. Junior members shall be persons engaged in academic study toward a career in those areas described in Section 2 of this Article, but not currently employed in those areas. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members in Section 2 of this Article, except that they need not be recommended by a member of the Association. The term of junior membership shall be limited to five years.

ARTICLE IV

OFFICERS

Section 1. The officers of the Association shall be a president, a senior vice president, two junior vice presidents, a treasurer and nine directors, who, with the most recent past president, shall constitute the Executive Committee.

Section 2. The past presidents of this Association, previous to the most recent past president, who continue to be members shall be privileged to attend all meetings of the Executive Committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the Executive Committee without delay.

ARTICLE V

EXECUTIVE COMMITTEE

Section 1. The Executive Committee shall manage the affairs of the Association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the Association, and make all necessary purchases and contracts required to conduct the general business of the Association, but shall not have the power to render the Association liable for any debt beyond the amount then in the treasury plus accounts receivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the Association.

Section 2. Meetings of the Executive Committee may be called by a majority of the members of the committee, providing ten days' notice is given to the executive committee by mail.

Section 3. Five members of the Executive Committee, one of which shall be either the president or a vice president, shall constitute a quorum for the transaction of business.

ARTICLE VI

ELECTION OF OFFICERS AND SECRETARY AND TENURE OF OFFICE

Section 1. Except as otherwise provided, the officers shall be elected at the regular annual meeting of the Association and the election shall not be postponed except by a two-thirds vote of the members present at said annual meeting. The election shall be by vote, a majority of the votes cast being required for election. Any member of the Association not in arrears for dues shall be eligible for office, but the president shall not be eligible for re-election.

Section 2. The president, two junior vice presidents, and treasurer shall hold office for one year and the directors for three years; three directors being elected each year. The senior vice president shall hold office for one year and ascend to the office of president at the expiration of such service. All officers shall retain their office until their successors are elected and installed. A director elected for a three-year term shall not be eligible to serve two consecutive terms.

Section 3. The term of office of the treasurer may be terminated at any time by two-thirds vote of Executive Committee. The compensation of the treasurer shall be fixed by a majority vote of the Executive Committee.

Section 4. The secretary shall be appointed by a majority vote of the Executive Committee and the term shall terminate with the appointment of successor. The Executive Committee shall have the power, by two-thirds vote, to remove the secretary and appoint a successor at any time. The salary of the secretary shall be decided by a majority vote of the Executive Committee.

Section 5. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the Executive Committee.

ARTICLE VII

MEMBERSHIP FEE AND DUES

Section 1. Every member, upon joining this Association, shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the Executive Committee.

Section 2. A person stricken from the list of members because of non-payment of dues upon written application may be reinstated as a member in the former class of membership without loss of privileges, either upon payment of all back dues (which must accompany applications) or at the discretion of the Executive Committee voting in the manner prescribed in Section 2 of Article III.

ARTICLE VIII

LOCAL SECTIONS

Section 1. Upon the application of ten or more members of the Association residing in the same geographical district, or having offices therein, the Executive Committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this Association as the section membership may adopt and the Executive Committee approve.

Section 2. The parent Association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

By-Laws

(Revised December 2, 1990)

Time of Meeting

1. The regular meeting of this Association shall convene annually during the month of September, the exact date to be fixed by the Executive Committee.
2. It shall be within the power of the Executive Committee to change the time of the meeting if it becomes apparent that it is for the best interests of the Association.

Place of Meeting

3. The place of holding the annual meeting shall be determined by the Executive Committee not less than twelve months prior to the date of the annual meeting.

Quorum

4. At the regular meeting of the Association, 15 or more members shall constitute a quorum.

Dues

5. The annual dues for the fiscal year ending August 31, and payable in advance, shall be as follows:
Members, \$20.00; Associate Members, \$20.00; Junior Members, \$20.00

Duties of Officers

6. The president shall have general supervision over the affairs of the Association. He shall preside at all meetings of the Association and of the Executive Committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. The president shall render a detailed report at least three times during the year to the members of the Executive Committee, showing the financial condition of the Association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the Association.

7. The vice presidents, in order of seniority, shall preside at meetings in the absence of the president and discharge the duties of the president in case of a vacancy in his office. The senior vice president shall have the senior position of vice presidents.

8. The secretary shall keep a correct record of the proceedings of all meetings of this Association, and of all accounts, between this Association and its members, collect all moneys due the Association, and deposit the same in the name of the Association. The secretary shall pay all bills when properly certified and approved by the president or the treasurer, and make such reports as may be called for by the Executive Committee. The secretary shall sign all contracts or other written obligations of the Association which have been approved by the Executive Committee. The secretary shall also perform such other duties as the Association may require.

9. The treasurer shall have charge of the funds, check all deposits as made by the secretary, and invest all funds not needed for current expenses. The treasurer shall report at each annual meeting on the condition of the finances.

Nominating Committee

10. After each annual meeting the president shall appoint a committee consisting of five members. The most immediate past president shall act as chairperson. No other officers of the Association shall be appointed to this committee. This committee shall prepare a list of names of nominees for officers to be voted on at the next annual meeting in accordance with Article VI of the Constitution, said list to be read at the business session of said meeting. Nothing in this section shall be construed to prevent any member making further nominations provided that such nominations are received by the president in writing not less than thirty (30) days in advance of the first day of the annual meeting. Such nominations should be addressed to the president of the Association at its headquarters office.

Auditing Committee

11. Prior to each annual meeting the president shall appoint a committee of three members, not officers of the Association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

Orders of Business

12. Call to order by president.

Opening prayer or invocation.

President's address

Reports of standing committees and presentation of papers

Election of officers

Business session

Report of secretary

Report of treasurer

Report of auditing committee

Report of necrology committee

Unfinished business

New business

Installation of officers

Adjournment

Decisions

13. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the Association, unless otherwise provided. Unless specifically provided herein otherwise, all discussions shall be governed by Robert's Rules of Order.

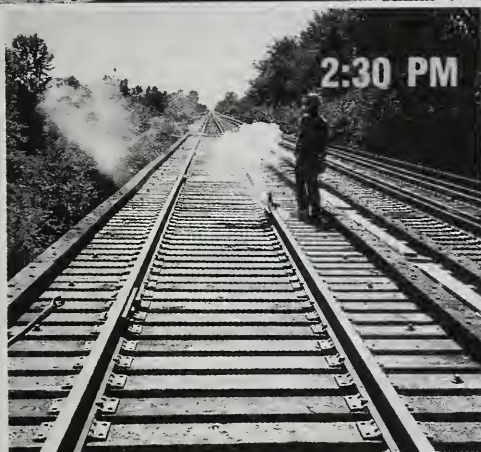
Amendments

14. The By-Laws can be amended by a two-thirds vote of those present at any regularly called Executive Committee Meeting.

ACTIVE MEMBERS

Joined

Adams D A, Mgr Bridge Mtee, UP RR, 2333 Walnutwood, Baton Rouge, LA 70816	09-26-84
Allen J P, Engr Strs, NS Corp, 99 Spring St, Atlanta, GA 30303	09-20-87
Anderson B R, Corp Qlty Cncl, Conrail, 2605 Interstate Dr, Harrisburg, PA 17110	10-04-82
Anderzunas P P, Asst Div Engr, Conrail, 211 Knotty Oak Dr, Mt Laurel, NJ 08054	05-08-84
Anthony O D, Chf Engr, B&A RR, North Me Jct Pk, RR 2 Box 45, Bangor, ME 04401	10-05-71
Aplegate D, Mgr Of Bridge Mtee, UP RR, 833 E 8th St, Stockton, CA 95206	07-24-91
Armenta C G, Supv Strs, AT&SF RY, 12969 Road 37, Madera, CA 93637	10-07-82
Bagwell M W, Chf Engr, Mississippi Export RR, PO Box 8743, Moss Point, MS 39562-8743	03-16-88
Bailey J, Supv B&B Dept, NIRC/METRA, 14736 S Major, Oak Forest, IL 60452	08-31-77
Baker R C, Asst Engr Trk & Strs, EJ&E RY, PO Box 899, Gary, IN 46401	09-14-80
Bandlow P M, Sr Engr Strs & Fac, Amtrak, 30 St Sta, 3rd Flr S, Philadelphia, PA 19103	08-20-91
Barrett J E, President, Bowman, Barrett & Assocs, Inc., 233 N Michigan, Chicago, IL 60601	12-09-71
Barrett P L, Engr Const & Mtee, AT&SF RY, 4515 Kansas Ave, Kansas City, KS 66106	02-17-82
Barron R A, Supv Strs, Conrail, PO Box 234, Sherman Dale, PA 17090	04-26-91
Bartholomew D E, Sr Proj Mgr RR Facilities, Sverdrup Corp, PO Box 97062, Kirkland, WA 98083-9762	09-15-86
Batemann J D, Mgr Bridge Mtee, UP RR, 8831 Silent Stream, San Antonio, TX 78250	12-03-82
Battle, Jr E A, Sr Engr Shops & Yards, Metro North Commuter RR, 347 Madison Ave, 11th Flr, New York City, NY 10017	09-21-87
Beard E E, B&B Supv, IC RR, RR 1, Box 69B, Sigel, IL 62462	07-24-91
Beattie G W, Asst Supt Mtee, AT&SF RY, 6707 Adirondack Trl, Amarillo, TX 79106-2803	11-05-82
Beebe L C, Mgr Sfty Svcs, UP RR, 1416 Dodge St, Rm 800, Omaha, NE 68179	12-04-85
Begg W B, Engr Of Strs, CC&P RR, 1006 E Fourth St, Waterloo, IA 50703	10-08-91
Begnaud R A, Asst Engr/Br Dsgn, Amtrak, 2961 Hale St, Philadelphia, PA 19149	05-08-84
Beirne J M, Mgr Trk Insp & Dvlpmnt, NS Corp, 110 Franklin Rd SE, Roanoke, VA 24042-0077	08-20-76
Beitzel M J, Sr Engr Tech, Modjeski & Masters, 2408 Lynnbrook Dr, Harvey, LA 70058	09-22-91
Belkoulou E, Sr Bridge Engr, Transport Canada, 344 Slater St, Ottawa, ONT, Canada, K1A 0N5	09-16-90
Bender S, Supt Of Mtee, Pittsburgh & Conneaut Dock Co, PO Box 90, Conneaut, OH 44030	07-18-90
Benes R F, Resident Engr, Larsen Engr's, 3955 Yale St, Hamburg, NY 14075	04-27-87
Bennett C P, Asst Engr-Grd Sprtn Strs, NS Corp, 99 Spring St SW, Atlanta, GA 30303	01-09-90
Benton, III W, Asst Engr Bridges, NS Corp, 99 Spring St SW, Atlanta, GA 30303	08-17-88
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Best R E, Engr. Mgr. Strs., State Rail Authority-New So. Wales, 12G Church St, Parramatta, NSW, Australia, 2150	09-16-90
Bhalakia M P, Asst CE-Dsgn, Constr&Envir, P&LE RR, Store House A, McKees Rocks, PA 15136-2693	09-16-73
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Burns B T, Structure Engr, AT&SF RY, 920 SE Quincy, Topeka, KS 66612-1116	03-03-78
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Busboom G G, Sr Dsgn Tech, ESCA Consultants Inc, PO Box 159, Urbana, IL 61801	03-21-88
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Calhoun R L, Associate, Hazeltel Erdal, Inc, 547 W Jackson Blvd, Ste 1500, Chicago, IL 60661	09-18-88



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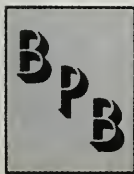
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Castrucci A, Asst Div Engr-Strs, Conrail, 31 E Georgia St, Rm 300, Indianapolis, IN 46204	05-04-82
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Cerny L T, Exec Dir, AREA, 50 F St NW Ste 7702, Washington, DC 20001	03-26-80
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Charles H H, Engr Strs, Providence & Worcester RR, PO Box 1188, Worcester, MA 01601	02-06-89
Charrow A M, Asst Supt Mtee, AT&SF RY, 106 N First St, Belen, NM 87002	10-04-82
Chopra S K, Engr Brs & Strs, CP Rail, Union Sta 65 Front St, Rm 366, Toronto, ONT, Canada, M5J 1E8	09-19-88
Cieszynski R, Supv Of Strs, Conrail, 3340 Grandveiu Dr, York Haven, PA 17370	01-10-92
Clark J W, Engineer, 174 Marshall Bridge Dr, Greenville, SC 29605-1247	03-31-87
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Cooper L M, Strs Supv, UP RR, 1416 Dodge St, Rm 1000, Omaha, NE 68179	07-24-91
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Coventry K J, Chf Engr, Algoma Central RY, Box 7000, Sault Ste Marie, ONT, P6A 5P6	09-28-66
Covill C A, Asst Supv Strs, Conrail, 3520 Plumey Rd, Northwood, OH 43619	12-03-87
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Crighton J T, B&B Master, CP Rail, PO Box 4100, Agincourt, ONT, Canada, M1S 4A8	09-17-90
Criger L E, Mgr Civil Dept, Pritchard Corp, 8205 W 108th Terr, Overland Park, KS 66210	10-22-87
Cross R G, B&B Supv, NS Corp, PO Box 540, Eaton, IN 47338-0540	09-15-86
Culbertson B R, Mgr Of Strs, C&NW Trans Co, 900 Story St, Boone, IA 50036	09-20-87
Cunningham W P, Engineer, Missouri Cities Water Co, 18 Great Lakes Dr, St Peters, MO 63376-3226	08-12-81
Darnell K E, Vice President, ERCE, PO Box 22879, Knoxville, TN 37933	03-25-83
David W B, Midwest Reg Mgr, Seelye Stevenson Value & Knecht, 700 W Madison St, Ste 2840, Chicago, IL 60602-4207	03-18-87
David G A, Bridge Engr, FRA, 400-7th St SW (RRS-11), Washington, DC 20590	03-22-73
Davidson H L, Engr B&B, CSX Transportation, PO Box 1500 Lynn Avenue, Corbin, KY 40701	08-14-86
Davis D R, Dir Of Ops, Atlanta & St Andrews Bay RY, PO Box 2775, Panama City, FL 32402	05-16-73
Davis G, Rdmrstr, McCloud River RR, PO Box 1500, McCloud, CA 96057	06-07-90
Davis R L, B&B Supv, Soo Line, 9 Monroe St, Elgin, IL 60123	02-17-82
Day F D, Sys Engr-Strs/Mtee, Conrail, 6 Penn Center Plaza, Philadelphia, PA 19103-2959	05-01-49
DeBerg D G, Asst Mgr-Rail, AT&SF RY, 5108 Shunga Dr, Topeka, KS 66614-1477	10-04-82
DeHart J R, Proj Supv, NS Corp, 8 N Jefferson St, Roanoke, VA 24042-0049	08-17-88
Del Signore P L, Engr B&B, Conrail, 209 Belladonna Dr, Glenshaw, PA 15116	06-07-90
Del Vecchio S, Br Engr, CN RY, PO Box 8100, Montreal, QUE, Canada, H3C 3N4	06-01-89
Dennis W B, B&B Supv, Iowa Interstate RR, 1007 W Main, Anita, IA 50020	12-14-84
Dermer A L, Lead Rail Dsgnr, Carter & Burgess, Inc., 7950 Elmbrook Dr, #250, Dallas, TX 75247	12-12-88
Dettering D L, Dir-Strs Dsgn, UP RR, 1416 Dodge St, Rm 1000, Omaha, NE 68179	08-28-85
Dickerson R D, Bldg Mtee Engr, NS Corp, 99 Spring St, Atlanta, GA 30303	09-20-87
Dobranetski E B, Chf-Major Invest. Branch, Natl Trans Sfty Bd, 800 Independence Ave SW, Washington, DC 20594	03-18-70
Dolby A J, Dolby & Assoc., Inc., Rd #4, Box 85, Seaford, DE 19973	02-28-75
Doss P R, B&B Supv, NS Corp, PO Box 15074, Asheville, NC 28813-0074	09-26-84
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Dout K R, Strl Supv, AT&SF RY, 11300 Burgan Ne, Albuquerque, NM 87111	10-04-82
Drake D W, B&B Supv, NS Corp, PO Box 980, Moberly, MO 65270	10-08-91
Draper B L, Asst Supt Mtee, AT&SF RY, PO Box 9, Wellington, KS 67152-0009	02-22-83
Driscoll D J, Mgr B&B, BN RR, 5324 Trent, Spokane, WA 99212	09-18-78
Duncan D R, Bridge Insp, IC RR, PO Box 111, Goreville, IL 62939	08-20-91
Dunn H A, B&B Supv, IC RR, 506 Carrollton Ave, Greenwood, MS 38903	03-16-88
Dunn T V, Bridge Engr, C&NW Trans Co, 165 N Canal St, Chicago, IL 60606	02-17-82
Dunsworth J E, Mgr Bridge Const, UP RR, 2801 Rock Creek Pkwy, N Kansas City, MO 64117	09-07-83
Dwinnell W B, Chf Mech Off, LI RR, Jamaica Station-25C, Jamaica, NY 11435	02-22-83
Dziak J E, Proj Mgr, IHB RR, 2721-161st St Box 389, Hammond, IN 46325	09-17-80

**1920
Model 10**



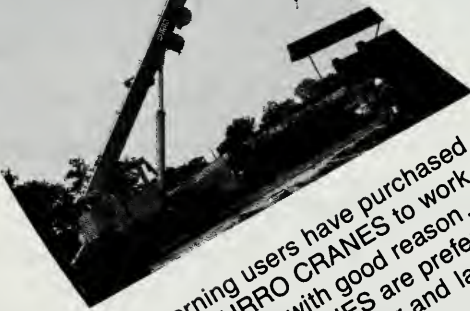
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Gilbert T M, Bridge Insp, Conrail, 11420 Woodtown Rd, Galena, OH 43021	08-29-89
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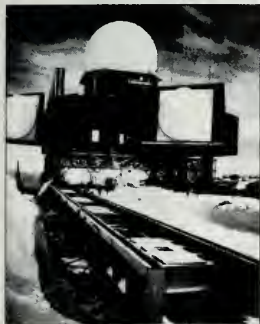
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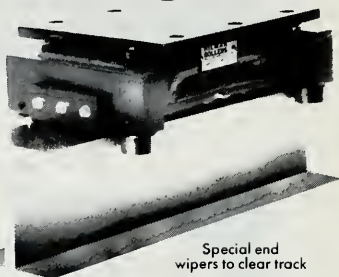


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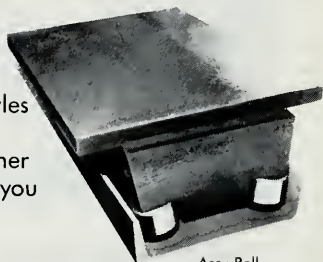


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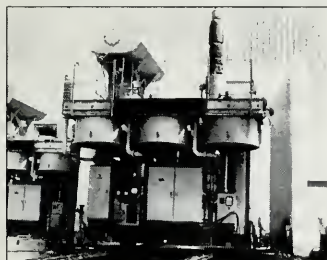


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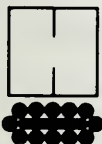
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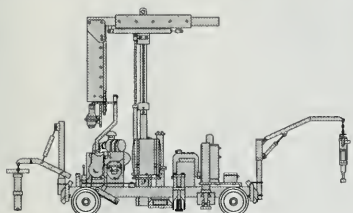
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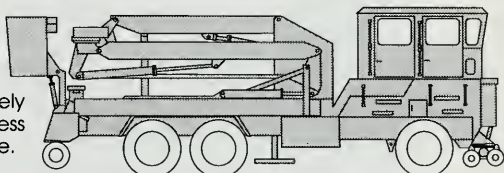
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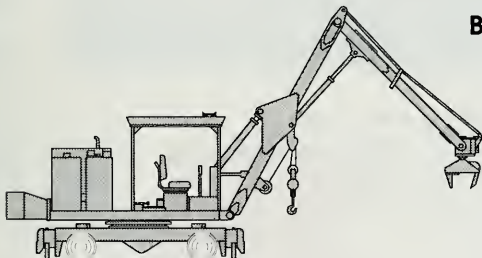
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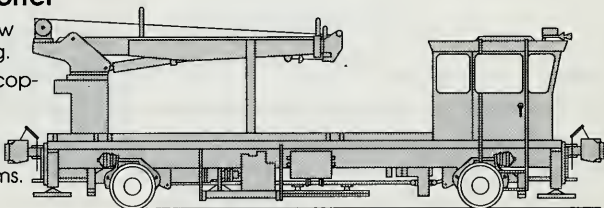
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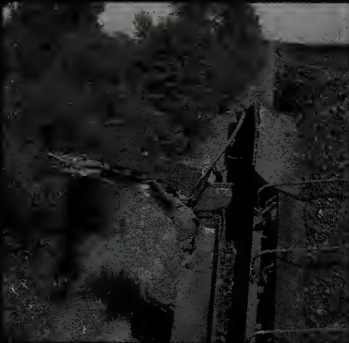


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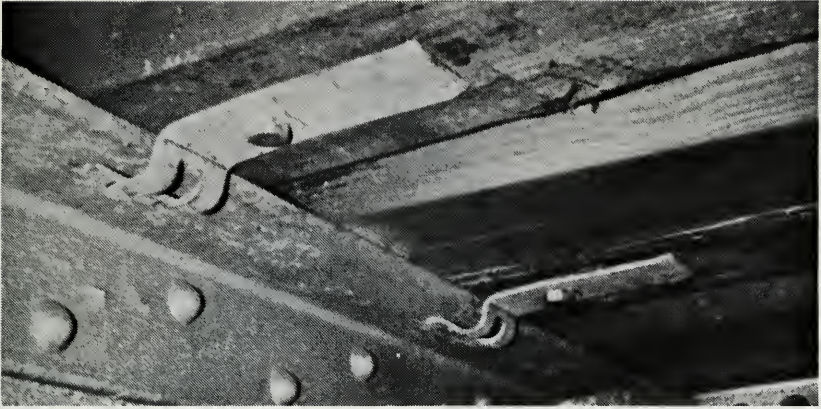
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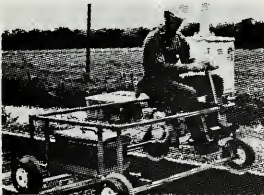
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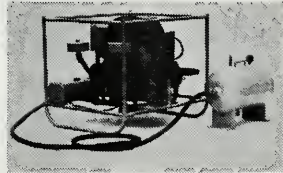
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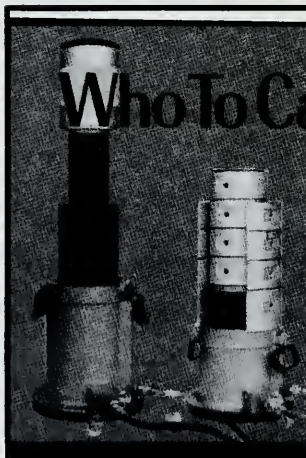


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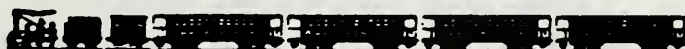
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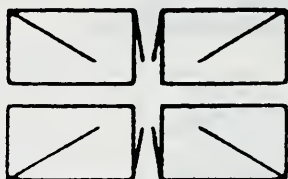
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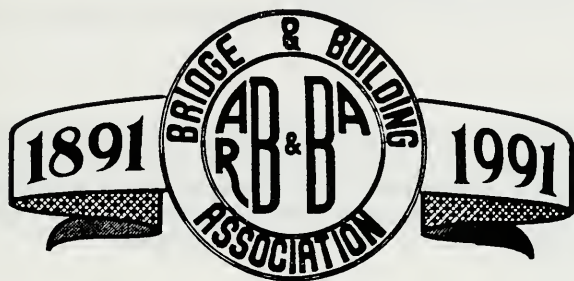
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(Extract from Constitution)

Article III - Membership

Sec. 1. The membership of this association shall be divided into five classes, viz; Members, junior members, life members, associate members and honorary members.

Sec. 2. A member shall be a person in the railway industry (except representatives of manufacturers and/or suppliers of equipment, material or labor services , or individuals who are subject to collective bargaining) engaged in engineering, construction and maintenance of railway structures and fixed facilities; a person in the employ of a public regulatory body; a professor of engineering or architecture; a technical editor; a materials expert; a consulting engineer, or an engineer employed by a consulting engineering firm, engaged in the engineering, construction and maintenance of railway-related facilities; an engineer employed by a technical service or research and development organization; or an officer or engineer of an engineering or scientific society or association whose aims and objectives are compatible with the aims and objectives of this Association. Any person desirous of becoming a member shall make application upon the form prescribed by the Executive Committee, setting forth the applicant's name, address and practical experience. The applicant shall be recommended by at least one member of the Association to whom they are personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the Executive Committee, a majority vote being necessary in either instance.

Sec. 4. Associate members shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to cooperate with members in the study and development of improved practices in the construction and maintenance of railway structures and fixed facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Sec. 2 of this Article, except that they shall be recommended by either a member or an associate member of the Association to whom they are personally known.



